

Zurich University of Applied Science (“ZHAW”)

School of Management and Law (“SML”)

Institute for Banking, Finance and Insurance

Bachelor of Science (“BSc”) in Business

Administration with a major in Banking & Finance

2015 – 2019

Bachelor thesis

Predictive powers

*Performance of US private equity buyout funds and their time lag to
the US public markets*

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submitted on 21 May 2019

Management summary

North America, with USD 272 billion of aggregated capital raised for private equity funds (over 60% of the global volume), is the world's most important market for private equity, a well-established alternative asset class. Despite vast research on wave patterns of the private equity market and the identification of drivers on an aggregated level, academia still lacks the provision of indicators of ideal private equity investment timing. Therefore, this study attempts to shed some light on the time lag of the relationship between the increase in private equity deal activity influenced by US public market proxies and subsequent upsurging performance of US private equity funds.

This study employs quantitative research methods to approximate the mentioned time lag. A proprietary data set by courtesy of Preqin, a globally leading provider of private equity data, containing comprehensive cash flow data from over 800 private equity buyout funds from the vintage years 1990 – 2013 was obtained and enriched with various performance measures, such as the Internal Rate of Return or the Distribution to Paid-in Capital Multiple. Subsequently, the relational theoretical framework was considered for the development of public market proxies (mainly derived from aggregated company-level data from the S&P 500 Index), which were assessed for their correlation with lagged private equity performance data. It was concluded that both the neoclassical theory (measured using the operating margin, profit margin and capital expenditure) as well as the concept of information asymmetry (measures using the price-to-book ratio of non-dividend paying companies and the spread thereof to the price-to-book ratio of dividend paying companies) allow for the estimation of the time lag. Based on cross-multiplication of individual time lags and an isolated control and robustness test, it was concluded that three (vintage) years after public markets improved US private equity returns follow suit.

The study has shown that proxies of public markets have predictive characteristics in approximating the time lagged upsurge in private equity performance. Besides the contribution to academia's current body of literature on the subject, the results are of particular interest to investors when deciding on the timing of their private equity investments. As the study only focused on US private equity buyout funds, follow-on studies may extend the scope to other private equity sub-classes, such as venture capital, or include other geographical focuses. Additionally, while the results may apply to the examined data set from a retro perspective point of view, only upcoming market developments can reaffirm their validity for the future.

Acknowledgements

The thesis at hand is a result of my great interest in the private equity sector, which was strongly sparked by Thomas Ritter, founding partner of Multiplicity Partners, a Zurich-based investment boutique specialized in providing liquidity solutions to holders of private market funds and distressed assets. I am indebted to the entire Multiplicity Partners team and partnership, first and foremost to Thomas and Andres Hefti, for the invaluable inputs and for challenging my research approaches, hypotheses and results.

Further, a big thank goes to Hugues Pigné, Sales Manager at Preqin, who provided extraordinary support during the data procurement phase. The data set provided was crucial to the success of this thesis. Similarly, I thank Ellie Vicheva from PitchBook for useful private equity market research material.

Additionally, I am grateful to Prof. Dr. Hans Brunner for the flexibility and freedom he granted me in pursuing this thesis. His support and supervision were greatly appreciated throughout the entire process. Likewise, I thank the management of KPMG Switzerland and my team colleagues for the flexibility and support, enabling me to take time off – also during busy times.

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List of Abbreviations

CF	Cash flow
CIF	Cash inflow
COF	Cash outflow
DPI	Distribution to Paid-in Capital multiple
EURIBOR	Euro Interbank Offered Rate
Fed	US Federal Reserve System
GDP	Gross Domestic Product
IPO	Initial Public Offering
IRR	Internal Rate of Return
LIBOR	London Inter-bank Offered Rate
NAV	Net Asset Value
NPV	Net Present Value
OECD	Organisation for Economic Co-operation and Development
RVPI	Residual Value to Paid-in Capital multiple
TVPI	Total Value to Paid-in multiple
USD	US Dollar

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1 Introduction

1.1 Motivation of research and the importance of private equity

In June 2017, global assets under management¹ by private equity firms reached USD 2.8 trillion, an increase of almost 10% from the previous year and more than doubling during the past decade (Preqin Limited, 2018, p. 24). A Preqin survey (2018, p. 13) found that 37% and 53% of institutional investors are planning to increase private equity commitments in their portfolio in 2018 compared to 2017 and in the longer term, respectively. In 2017, more than 5,300 active private equity firms employed approximately 108,400 people (Preqin Limited, 2018, p. 52). In addition, Preqin (2018, p. 64) noted that buyout funds have outperformed other private equity investments including venture capital as well as public market indices² over a three-year horizon to June 2017. Motivation is given to elaborate on the time lag of private equity performance to public markets, among others, due to academia's ongoing discussion on whether private equity performance adequately compensates for its risk profile and liquidity properties, findings on the performance' "procyclical systematic components" (Robinson & Sensoy, 2016, p. 521) and neoclassical reasoning being a "considerable part of variance in private equity investment activity" (Sommer, 2010, p. 249).

1.2 Problem statement and research gap

The body of academic analysis of the private equity industry is growing in terms of predictive powers and factors impacting on the performance of such, however, among others due to data availability, comprehensive analytics on predictive powers allow for further analysis in form of this paper. Academia found consensus on certain indicators predicting the performance of private equity funds³, unlike the public markets' infamous "past performance is no guarantee of future results" disclosure requirement Rule 156 of the Securities Act of 1933 by the U.S. Securities and Exchange Commission. Previous research was often conducted using aggregated data set (Kaplan & Schoar, 2005) or were based on private equity investments undertaken by a single institutional investor (Ljungqvist & Richardson, 2003). Further, academia's current body of literature

¹ Assets under management by private equity firms consist of (i) uncalled capital commitments (dry powder); and (ii) unrealized value of portfolio assets. As at June 2017, dry powder and unrealized value amounted to USD 978 billion (34.6%) and USD 1,851 billion (65.4%), respectively (Preqin Limited, 2018).

² Public market indices used in the comparison were (i) S&P 500 Index; (ii) MSCI* Europe; (iii) MSCI* Emerging Markets; and (iv) small-cap stock market index Russel 2000 TR. *MSCI was formerly known as Morgan Stanley Capital International.

³ For example, Kaplan & Schoar (2005) with evidence on persistence of sequence funds of the same general partner affirmed by Axelson, Strömberg & Weisbach (2010), Chung, Sensoy, Stern & Weisbach (2010) as well as Phalippou & Gottschalg (2008).

neglected relevant performance measures such as the Distribution to Paid-in Capital Multiple (“DPI”) or relevant metrics for not yet liquidated funds. Lastly and most importantly, academia lacks the quantification of the time lag between identified predictive powers to upsurging performance of private equity funds.

Hence, it is this study’s goal to identify the time lag between improving public markets (measured by means of proxies) and subsequent increased private equity performance. Mitigating above-mentioned limitations of preceding studies, a comprehensive data set containing over 800 private equity funds’ cash flow data is used by considering additional performance measures with relevance to practitioners.

1.3 Research questions / hypotheses

This study employs quantitative research methods in order to approximate the time lag between improving public markets and subsequent higher levels of private equity performance. Improving public market levels are identified by means of proven public market proxies (Sommer, 2010). Subsequently, correlation analyses will be conducted, in a first instance to assess the time lags between improving public markets and upsurging investment activity as well as between higher investment activity and improved private equity performance. Secondly, the robustness of these individual time lags will be tested by directly assessing the time lag between more benign public markets to higher levels of private equity performance.

1.4 Boundaries

The study at hand shows certain limitations, which are particularly caused by the lack of availability of more granular cash flow data. Firstly, the data set provided (see section 3.1) only includes buyout funds. Further, over 60% of all buyout funds contained in the data are focusing on the US market. Hence, the empirical analysis (see section 4) is limited to these US buyout funds and corresponding US public market data. Secondly, the data set does not allow for the analysis of individual private equity transactions, as only fund-level cash flows are available therein. Consequently, for the agency theory no adequate proxies were available as described in section 4.1.1 and 4.1.2. Thirdly, this study relies on public market proxies, which constitute “imperfect measures of the postulated drivers” (Sommer, 2010, p. 253). Following Sommer (2010), this limitation was

anticipated in the selection of public market proxies for each theoretical reasoning (see sections 2.3 and 4.1.2). Fourthly, the empirical analysis does not consider different p-value significance levels (e.g. 0.01, 0.025 and 0.05), but considers all correlations as statistically relevant below the threshold of 0.05. Lastly, the validity of the quantified time lag is ensured from a retrospective point of view, however, only future market developments can reaffirm its ongoing validity.

1.5 Relevance to academia and practitioners

The anticipated quantification of the time lag between improving public markets (measured by means of proxies) and subsequently higher levels of private equity performance is of particular relevance to practitioners (i.e. investors) when deciding on the timing of their private equity commitments. Further, this study is intended to further close gaps in academia's current body of literature on performance of private equity and the interlinkage between public and private equity markets.

1.6 Structure and focus areas of the thesis

The structure of this study follows its intention to quantify the time lag between improving public markets and subsequently higher levels of private equity performance. Section 2.1 gives an overview and discussion of the private equity market, transaction structures and performance measures. A historical overview of private equity boom and bust cycles including information on the current industry is given in section 2.2. Next, the theoretical framework that forms the basis to the hypothesis and proxy development, is established and described in section 2.3. In section 3.1 and 3.2, the data and corresponding descriptive statistics are elaborated on, respectively. The research methodology employed is disclosed in section 3.3 followed by the hypotheses' and public market proxies' development in section 4.1. Section 4.2 gives an overview of the results of the studies' empirical analysis. Lastly, the study's results are summarized and concluding remarks are given in section 5.

2 Background and theoretical framework

2.1 Private Equity investments

2.1.1 Actuality and definition

Alternative investments in general and private equity in particular (this also applies to hedge funds) offer investors heterogeneous investment opportunities. Mostowfi & Meier (2013, p. 5 & 12) noted that alternative investments (incl. private equity), which predominantly differs to traditional asset classes in terms of liquidity, transparency and market efficiency, are well-established among institutional investors in North America. They further noted that European and Asian private equity markets are still lagging behind due to a less extensive degree of knowledge among institutional investors. These findings are further supported by data from Preqin's 2018 Global Private Equity & Venture Capital Report (2018, p. 36), which is depicted in Figure 1 showing significant differences both in terms of funds closed and of aggregated capital raised in 2017.

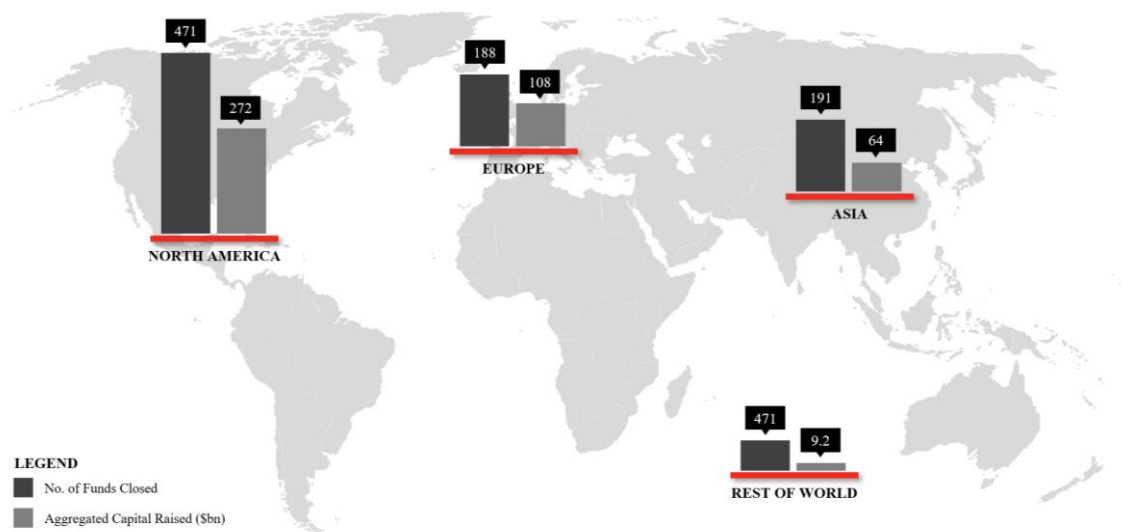


Figure 1: Fundraising of private equity funds in 2017 per geographical region

In terms of definitions for private equity, academia offers a vast variety, particularly concerning their scope and the degree of specification. For example, Bodie, Kane & Marcus (2013, p. 15) describe private equity as “investments in companies that are not traded on a stock exchange”, providing a very broad but simple definition. The Financial Times (2018) as well as Mostowfi & Meier (2013, p. 174) provide further granularity, the latter including five different sub-categories of private equity, one of which being “leverage buyouts”. For this paper, the definition from Preqin as presented in its 2018 Global Private Equity & Venture Capital Report (2018, p. 12) is followed: “private equity

[...is] the core asset class centered on the buyout and venture capital⁴ industry, together with other closely related strategies, including growth, fund of funds and secondaries”. This definition seems particularly relevant due to its following characteristics: (i) acceptable broadness; (ii) accounting for buyout funds given their importance in the private equity market; and (iii) consideration of the increasingly important secondary market.

As mentioned in section 1.4, this paper solely focuses on US buyout funds, i.e. private equity vehicles for the purpose of backing leveraged buyout transactions. Mostowfi & Meier (2013, pp. 183-184) characterize such transactions as follows: (i) high external / debt financing ratios⁵; (ii) mature and established companies as acquisitions targets; (iii) purchase price and no financing process; (iv) acquisition of a controlling / majority interest⁶; and (v) involvement / participation of the management⁷.

2.1.2 Structure of private equity investments

Usually, private equity funds are organized as limited partnerships and domiciled offshore due to tax considerations. Investors (so-called limited partners⁸) commit capital to the private equity fund with a typical life span around 10 years. The fund manager (so-called general partner) can then draw these capital commitments (so-called dry powder) to finance private equity transactions. Figure 2 depicts an exemplary private equity vehicle structure based on Mostowfi & Meier (2013, p. 175) in connection with Sommer (2012, p. 41), the latter being derived from Müller (2008, p. 17), Gilligan & Wright (2014) and Baker & Smith (1998, p. 176). A Preqin study (2018, p. 74) found that recently the investor structure of buyout funds shifted from a rather exclusive investor circle (25 or fewer investors) towards a more fragmented limited partner environment (26-50 investors). Between 2016 and 2017, 32% (2014-2015: 42%) of buyout funds had 25 or fewer investors and 42% (2014-2015: 25%) between 26 and 50 limited partners. Assets under management by private equity firms have grown significantly during the financial

⁴ As set out in section 1.4, venture capital is not in scope of this study.

⁵ Mostowfi & Meier (2013, p. 183) noted that the purchase price is typically financed with a minimum of 50% debt (often even exceeding 70%). Further they describe the ideal financing structure as follows: (i) 50% – 60% senior loan; (ii) 10%-15% mezzanine financing; and (iii) approximately 30% equity-financed (private equity fund capital).

⁶ Private equity fund managers prefer a controlling / majority interests of 75% – or more (Mostowfi & Meier, 2013, p. 184).

⁷ Depending on the size of the company, management normally holds an interest between few percentages up to 20% in leveraged-buyout transactions (Mostowfi & Meier, 2013, p. 184).

⁸ Usually, private equity investors are institutional investors, e.g. pension funds, (ultra) high net-worth individuals or banks (Fenn et al., 1998). More recently, Preqin (2018, p. 73) found that the most common institutional investor types as at January 2018 were a) foundations; b) private sector pension funds; c) public pension funds; d) family offices; and e) endowment plans.

crisis and reached USD 2.83 trillion in June 2017 split into USD 1,851 billion unrealized value and USD 978 billion in dry powder (Preqin Limited, 2018, p. 22).

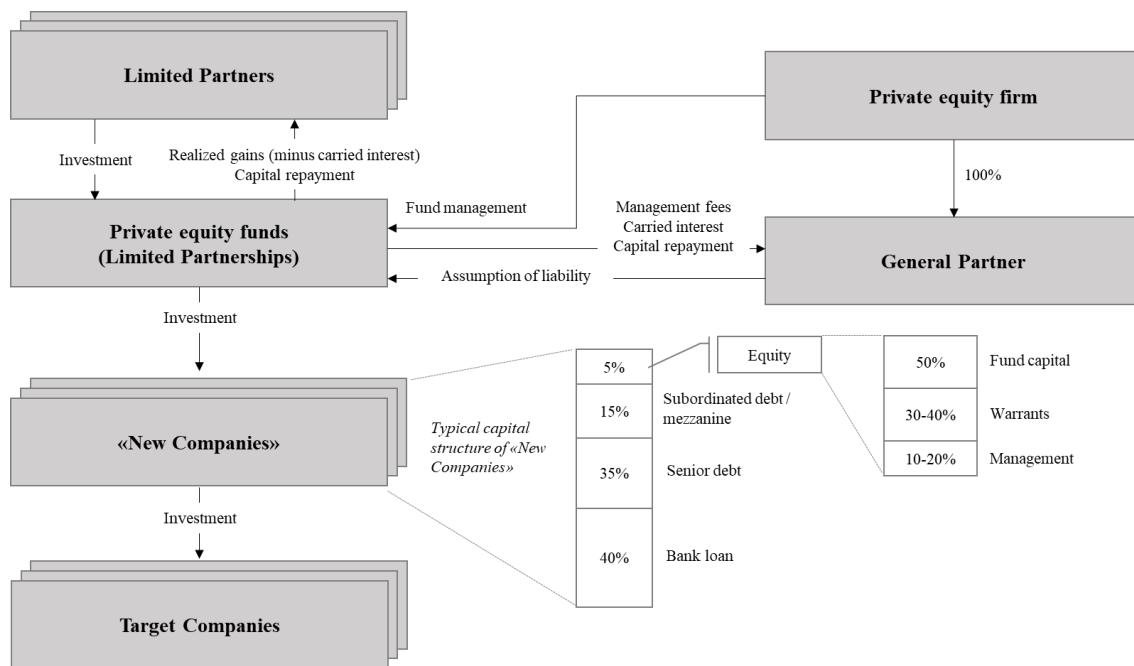


Figure 2: Illustrative structure of a private equity funds

Target (or portfolio) companies are of particular interest to buyout funds if they express characteristics such as (i) an undervalued/depressed stock price; (ii) willing management and shareholders; (iii) inefficient companies; (iv) strong and sustainable cash flows; (v) low leverage; or (vi) significant amount of unencumbered physical assets (CFA Institute, 2019).

2.1.3 Private equity performance

Performance is not only of concern to general and limited partners, but also to academia as there is still no clear consensus on whether the performance of private equity funds compensates adequately for the risks taken by investors. Preqin (2018, p. 64) found that buyout funds outperformed other private equity investments such as venture capital and outperformed public market indices⁹ over a three-year horizon. Bain & Company (2019, p. 32) even found that buyout funds outperformed public market indices based on the modified public market equivalent metric¹⁰ in the US, Europe and Asia over all

⁹ Private equity buyout funds outperformed the S&P 500 Index, the MSCI Europe Index, the MSCI Emerging Markets Index as well as the Russell 2000 Total Return Index on the three-year horizon to June 2017.

¹⁰ Cambridge Associates has (2019) developed the modified public market equivalent metric, which “is a proprietary private-to-public comparison that evaluates what returns would have been achieved had the dollars invested in private investments been invested in public markets instead”. Hereto, the “private investment cash flows” are evaluated to their value under “public market conditions”.

investment horizons (one to 20 years). Various research¹¹ indicates that private equity has outperformed indices of public markets during the past three decades, while especially private equity funds raised during a “hot fundraising market” seem to underperform (Robinson & Sensoy, 2016, p. 536). Performance has to be assessed in the context of cyclicity, which will be further investigated in the course of this paper. Other research, for example, Phalippou & Gottschalg (2008) find contradictory evidence, i.e. that private equity investments underperform public market indices, particularly where risk-adjusted metrics are considered. Regardless of the differing findings from academia, an investor survey by Preqin (2018, p. 73) found that 95% of investors felt their private equity investments met or exceeded their expectations during the past 12 months, which is consistent with findings from Bain & Company (2019, p. 18) noting that globally, limited partners were awarded for investments in buyout funds with positive net cash flows since 2011.

In connection with private equity performance, practitioners often refer to the so-called J-Curve¹² – see Figure 3 for an exemplary J-Curve enriched with insights from Coller Capital (2017, p. 6). The investment returns to investors are usually reduced by the general partner’s management fee and the performance-depending “carried interest”. Gompers & Lerner (1996, p. 481) found that the management fee is usually in the range of 1.5% - 2.5%. In terms of the carried interest, Fenn, Prowse & Liang (1998, p. 38) found the performance fee industry standard to be 20% acknowledging that the calculation parameters differ substantially across general partners and over time.

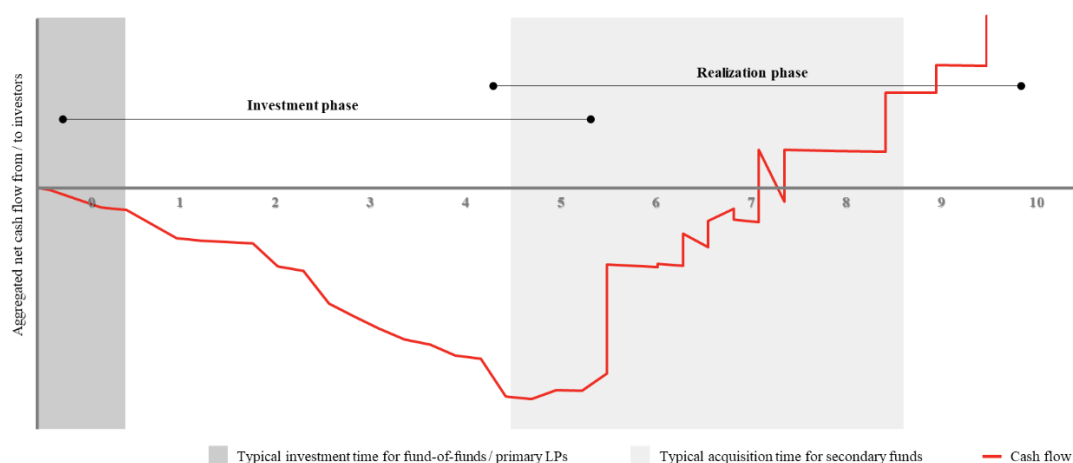


Figure 3: Illustrative J-Curve (based on the 2008 Carlyle Europe Technology Partner II fund’s aggregated cash flow)

¹¹ Robinson & Sensoy (2016, p. 522) provide a comprehensive overview of literature supporting the claim that private equity funds outperform public markets, among others, they refer to findings from Robinson & Sensoy (2011), Harris, Jenkinson & Kaplan (2012), Harris, Jenkinson & Kaplan (2014), Phalippou (2014) and Higson & Stucke (2012).

¹² The J-Curve depicts the cumulated net cash flows to investors and is named after the resemblance with the letter “J”.

Derived from the extensive overview of private equity performance metrics provided by Mostowfi & Meier (2013, p. 211 sq.), the below Equation 1 to 4 are commonly employed to assess the profitability of a private equity fund. In order to identify the realized average performance of a private equity investment, the Internal Rate of Return (“IRR”)¹³ is calculated based on the net cash flows to investors, i.e. the time-weighted difference between cash in- and outflows. Equation 1 is based on the Net Present Value (“NPV”) formula (Mostowfi & Meier, 2013, p. 211). Phalippou et al. (2008, p. 1767) find that IRR disclosures are biased upward on average, particularly, due to the lack of taking into account a overall fund’s duration.

Equation 1: Internal Rate of Return, IRR

$$NPV = \sum_{t=1}^T \frac{CF_t}{(1 + IRR)^t} = 0$$

where, CF depicts the cash flows over time.

The private equity funds’ performance measured in terms of their net IRR developed as depicted in Figure 4 over the time spawn from 1996 until 2014 – based on data from Preqin (2018, p. 95).

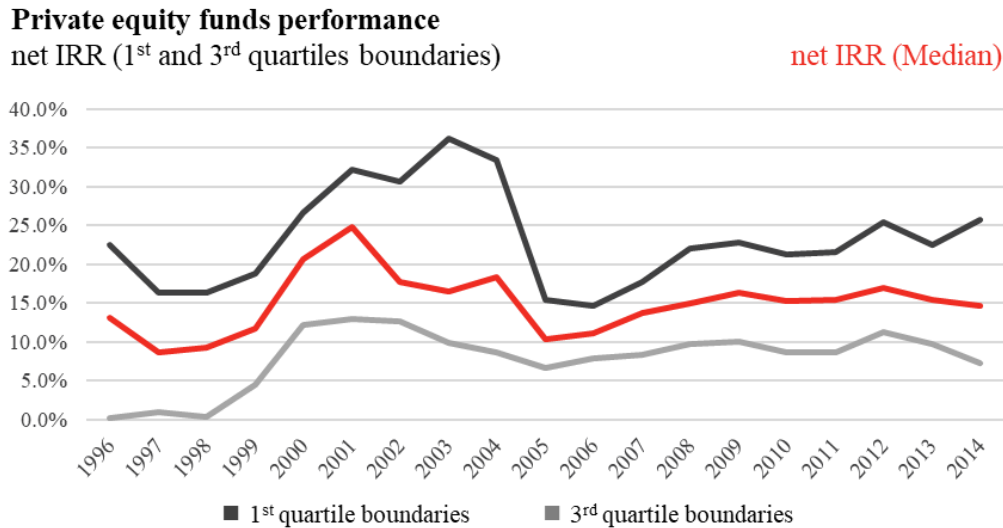


Figure 4: Private equity buyout performance benchmarks (globally)

Besides the abovementioned IRR, practitioners strongly rely on the DPI multiple, which assesses the relationship of cumulated cash in- and outflows to investors. Thus, Equation 2 solely considers invested amounts and payouts.

¹³ Mostowfi & Meier (2013, p. 211 sq.) make mentioning of the Interim-IRR, for not yet largely distributed or fully liquidized funds. In this paper, such funds’ performance is measure with the other performance matrices (see following page) as they are more commonly observable in industry reports, for example Preqin’s 2018 Global Private Equity & Venture Capital Report (2018).

Equation 2: Distribution to Paid-in Capital Multiple, DPI

$$DPI_T = \frac{\sum_{i=0}^T CIF_T}{\sum_{i=0}^T COF_T}$$

where, CIF depicts the cash inflows and COF cash outflows over time.

For the measurement of not yet liquidated funds' performance, the Residual Value to Paid-in Capital ("RVPI") multiple and the Total Value to Paid-in ("TVPI") multiple are used. As depicted in Equation 3, RVPI considers the Net Asset Value ("NAV") of not yet distributed participations of the private equity funds investments, hence, is subject to general partner estimates.

Equation 3: Residual Value to Paid-in Capital Multiple, RVPI

$$RVPI_T = \frac{NAV_T}{\sum_{i=0}^T COF_T}$$

where, COF depicts the cash outflows over time and NAV the estimated value of not yet distributed participations of the private equity fund.

As mentioned the DPI and RVPI performance measures are often combined for not yet liquidated funds, which results in the formula of the TVPI (see Equation 4). In case of fully liquidated private equity funds, the DPI and TVPI multiples are equal. Hence, the TVPI performance measure represents the estimated DPI multiple of a private equity fund at its liquidation.

Equation 4: Total Value to Paid-in Capital Multiple, TVPI

$$TVPI_T = \frac{\sum_{t=0}^T CIF_T + NAV_T}{\sum_{t=0}^T COF_T}$$

where, CIF depicts the cash inflows and COF the cash outflows over time, while NAV represents the estimated value of not yet distributed participations of the private equity fund.

2.2 Cyclicity of Private Equity

Based on the idea of financial instruments to move in recognizable patterns, i.e. so-called wave cycles, firstly established by R. Elliot (1994), both practitioners and (academic) industry observers claim that boom phases are followed by corrective (bust) ones. Drivers for such waves are elaborated in detail in section 2.3. The significance and magnitude of such wave patterns in the global private equity market from 1996 until 2018 is depicted in Figure 5 based on Bain & Company's Global Private Equity Report 2019 (2019, p. 4).

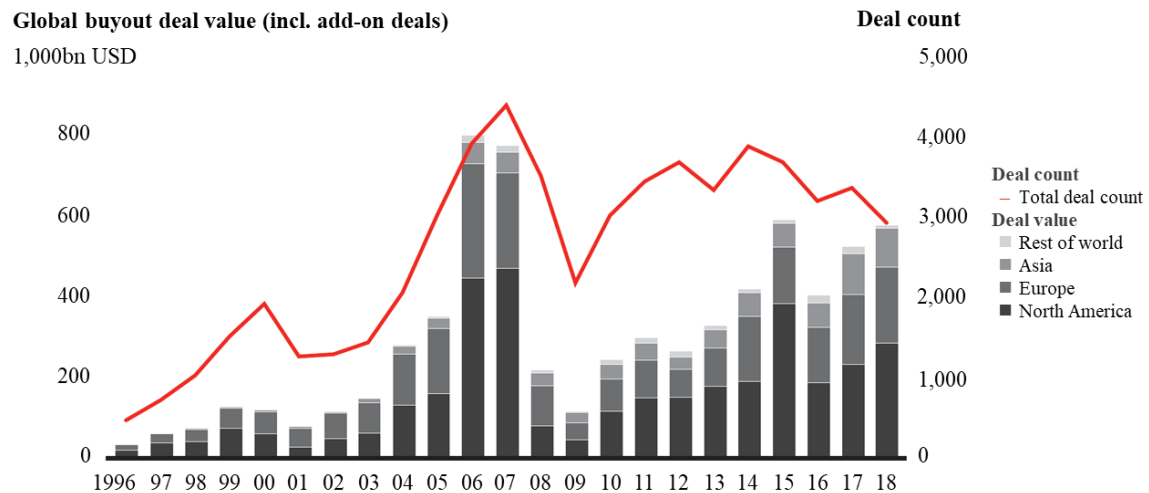


Figure 5: Historical overview of private equity activity

A comprehensive overview of private equity wave patterns is provided by Sommer (2010, p. 18 sq.) and key aspects thereof are elaborated in the following sections.

2.2.1 First buyout wave of the 1980s during the junk bond era

Upon establishment of the first private equity fund, American Research and Development Corporate in North America in 1946 (Fenn et al., 1998, p. 10), private equity markets initially experienced a first boom phase in the 1980s as part of the junk bond market. This initial boom phase was fuelled by (i) several public-to-private transactions with the purpose of re-focusing on corporates' core businesses¹⁴ (Shleifer & Vishny, 1990, p. 745); (ii) in response to structural shifts conducive to mergers and acquisitions or restructuring endeavors (Mitchell & Mulherin, 1996, p. 219); and (iii) financial innovation such as the significant debt-leverage ratios used for financing transactions in conjunction with bespoke tax strategies (Cheffins & Armour, 2008, p. 7). Kaplan & Holmstrom (2001, pp. 8-9) concluded that the 1980s buyout wave fuelled with debt was a successful measure against inefficiencies and led to improved operating performance of portfolio companies; academia identified the root cause of these deficiencies in the public market to be (i) companies' management; and (ii) inadequate corporate governance (Jensen, 1989, p. 7, Kaplan, 1997, p. 3, Shleifer & Vishny, 1990, p. 745). The first private equity wave was characterized by the hostility of corporate takeovers, financial restructurings and the overall pace of takeover activity (Kaplan S. N., 1997, p. 1, Renneboog & Simons, 2005).

¹⁴ Company managers were, among other factors, forced to such measures as a result of missing out on investor expectations (Brealey, Myers, & Allen, 2008).

The 1980s private equity boom phase peaked with KKR's¹⁵ famous USD 25bn RJR Nabisco¹⁶ purchase in 1989 (Burrough & Helyar, 2004).

The 1980s boom phase came to an abrupt end in 1989 when junk bond companies acting as incubators to the upsurge fell into financial distress. The downfall of Drexel Brunham Lamber, an American investment bank and junk bond dealer, concluded in the bankruptcy filing in February 1990 (Bruck, 1988) eventually marked the end of this boom phase (Smit & van den Berg, 2006, p. 15).

2.2.2 Second buyout wave of the late 1990s

In the early 1990s, investors' and the publics' trust and faith in the financial sector were restored, however, previously observed transaction levels remained in far distance (van Santen, 2009, p. 31). Rationales hereto were provided by Kaplan (1997) and Kaplan & Holmstrom (2001), according to which the pursued focus on shareholder value was institutionalized within the corporations themselves. Among others, the recovery of the private equity market was facilitated by a decline in price levels (Kaplan & Stein, 1993). Further, the 1990s boom phase was heavily driven by the tech boom characterized by "massively overvalued" companies (Blundell-Wignall, 2007, p. 71) as well as significant volumes of easily available cheap credit and fund liquidity growth (Acharya, Franks, & Servaes, 2007). Further, van Santen (2009, p. 31) noted that small and medium-size companies faced heavy burdens with the introduction of the Sarbanes Oxley Act and expensive listing costs. In addition, the second buyout wave was the first real European-driven boom phase, where the completed private equity deals in the UK exceeded 3% of the Gross Domestic Product ("GDP") (Blundell-Wignall, 2007, p. 72). The peak of this boom phase was in 1999 with almost 400 US buyout transactions and a total value exceeding USD 50 billion (Acharya, Franks, & Servaes, 2007, p. 1). Kaplan & Holmstrom (2001, p. 3) noted that the transactions during the second boom wave were less hostile compared to the preceding wave in the 1980s, among others, due to the increased costs of hostile takeovers and improved defense strategies.

¹⁵ KKR is a New York-based private equity firm. The company name is an acronym for the surnames of its founders Henry Kravis, George R. Roberts and Jerome Kohlberg Jr. (KKR, 2019).

¹⁶ RJR Nabisco was a US company resulting out of the merger of Nabisco, a US food processor company, and R. J. Reynolds Tobacco Company, a US tobacco company (Burrough & Helyar, 2004).

The above-mentioned focus on tech companies led to the inevitable shock of the private equity industry caused by the March 2000 Nasdaq crash (“bursting of the dot-com bubble”).

2.2.3 Third buyout wave of the 2000s (“Golden Age of Private Equity”)

The so-called “Golden Age of Private Equity” (Reuters, 2007) picked up speed after the financial markets were supplied with tremendous levels of liquidity, mainly from “petrodollars, huge government surpluses [...] as well as pension, foundation and private wealth” (Acharya, Franks, & Servaes, 2007, p. 2). Acharya et al. (2007, p. 3) identified the boom phase primarily to be fuelled by the “availability of syndicated bank debt”, which was also traded in form of collateralized loan obligations and on secondary markets. The boom phase marked a new age of mega-buyouts such as the going-private of General Motors. Further, renowned private equity firms such as Blackstone pursued an Initial Public Offering (“IPO”)¹⁷ during this boom phase (US Securities and Exchange Commission, 2008).

In connection with the sub-prime market and following the global financial crisis in 2007/2008, the annual aggregated private equity capital slumped from USD 414 billion in 2007 to only USD 213 billion and USD 178 billion in 2009 and 2010, respectively, marking the end of this boom phase (Preqin Limited, 2018, p. 10). As in previous waves, the boom phase lasted until markets overheated and the subsequent freezing of debt markets (Jensen & Chew, 2000).

2.2.4 Current status

Meanwhile, global buyout deal values (see Figure 5) as per Bain & Company (2019, p. 4) as well as other performance and size measures monitored by Preqin (2018) portray a continuously and organically growing industry and asset class. Bain & Company (2019, p. 1) describes the past five years as an “unprecedented success for the private equity industry”. However, with “a growing level of macro uncertainty” and general partners’ main challenge in 2018 were “finding the right asset at the right price” practitioners and industry observers have little doubt that the next downturn is around the corner –

¹⁷ As per US Securities and Exchange Commission Form 10-K for the fiscal year ended December 31, 2007 (US Securities and Exchange Commission, 2008), “the aggregated market value of the common units of [The Blackstone Group L.P.] as if June 30, 2007 was approximately USD 7,454.1 million”.

especially with the record amount of dry powder piled up amounting to USD 2,000 billion in December 2018 (Bain & Company, Inc. , 2019, pp. 3, 4 & 8).

2.3 Current theoretical framework

In this section, academia's findings on private equity markets are described, which build the basis for the hypothesis and proxies development (see section 4.1.1 and 4.1.2). Firstly, the theoretical framework concerning cyclicality and the relationship between public and private equity markets are discussed (see sections 2.3.1 until 2.3.4). Secondly, the implications of private equity investment activity¹⁸ on private equity performance are elaborated upon (see section 2.3.5). For the synopsis of the theoretical framework reference is made to section 2.3.6.

The cyclicality of private equity investment activity and especially the relationship to public markets was subject to only a fragmental percentage of the body of private equity literature. Sommer (2010) provided particularly useful additions to the current state of the art in this regard. Others – for example Robinson & Sensoy (2016) – identified that “both capital calls and distributions [to investors] have a procyclical systematic component”. The following sections 2.3.1 until 2.3.4 leverage from the theoretical framework described by Sommer (2010), in order to develop the hypothesis H-1 and corresponding proxies (see sections 4.1.1 and 4.1.2) regarding the relationship of public and private equity markets, among others, concerning the observable cyclicality in the latter's wave patterns as described in section 2.2.

2.3.1 Neoclassical theory

The neoclassical theory claims that shifts in investment opportunities due to “business cycles, variations in the liquidity of debt markets and industry-specific shocks” (Sommer, 2010, p. 27) lead to different levels of investment activity in private equity markets. Neoclassical economics are referred to as a metatheory, in other words a “set of implicit rules or understandings for constructing satisfactory economic theories” (Weintraub, 1993). Weintraub (1993) defines theories which are based on basic assumptions such as

¹⁸ In this paper, investment activity is referred to as investors' private equity capital commitments and general partners' capital calls. As described in section 3.2.1, investment activity is measured based on (i) capital called; (ii) the number of private equity funds; and (iii) the new entrants' ratio. Letter one refers to the percentual share of private equity funds, which launched their first private equity fund in a certain vintage year.

(i) people's preferences in terms of outcomes are rationale; (ii) individuals seek to maximize utility, whereas companies strive to maximize profits; and (iii) people's actions are considered independent, given complete and relevant information is available to them. Weintraub's (1993) findings led to other theories such as Fama's (1970) efficient market hypothesis, which is based on neoclassical economics. In terms of neoclassical economics' relevance to private equity investments, Sommer (2010) emphasized the importance of the distinction of capital demand (regarding companies need for financing) and capital supply (regarding investors' desire for attractive investments) besides the consideration of economic shocks, which for example can be measured by means of the GDP. Gompers, Kovner, Lerner & Scharfstein (2008, pp. 1-2) find that investors following neoclassical reasoning are expected to react to such shifts in investment opportunities. Hence, Sommer (2010) argues that upsurging economic prospects trigger such investment opportunities in line with Hirshleifer's findings (1958, p. 352) that investment decisions follow that present-value rule, i.e. seek "the highest possible level of present value". Ultimately, this results in higher investment activity.

2.3.2 Information asymmetry concept

Information asymmetry constitutes a key challenge of private equity investments due to their nature and can influence investment activity (Sommer, 2010, p. 34). In particular, the "adverse selection cost view" and the "value add view" are considered crucial, initially to general partners, however, from a spill-over perspective also on the behavior of investors.

Adverse selection, commonly known as Akerlof's (1970) "lemons problem", concerns target companies' information advantage when deciding on the acceptance of bidders' acquisition offers. Akerlof (1970, pp. 489-490) concluded that general partners offer lower bid offers in anticipation of this fact. Under advisement of Myers & Majluf's (1984) pecking order theory willingness to equity issuance is likely to raise adverse selection costs due to bidders' anticipation of a lower company value than the information, which is made available to company outsiders, might suggest. Due to the fact that incentives for equity issuance only exist if benefits thereof exceed costs associated with such maneuvers, including adverse selection costs. As information asymmetries differ over time according to Myers & Majluf's (1984) theory, Korajczyk, Lucas & McDonald (1992) found that firms tend to postpone the issuance of equity in anticipation of lower

adverse selection costs as a result of positive press releases. Supporting evidence on such timing concerns relating to high information asymmetry levels was provided by Wagner (2008) and Lowry (2003, p. 36). Wagner (2008) found high levels of management awareness regarding adverse selection costs leading to the postponement of equity issuance or pursuing debt financing causing lower levels of adverse selection costs Korajczyk et al. (1992). In addition, Lowry (2003, p. 36) identified that the degree of information asymmetry impacts timing decisions of IPOs. For private equity investments, high levels of information asymmetries arise in particular for the valuation of target companies with only few to none similar companies being subject to acquisitions (Sommer, 2010, p. 38). Consequently, boom phases lower adverse selection costs due to additional valuation comparison data as a result of each additional transaction, hence, private equity boom waves inherently increase deal activity.

Value-add view refers to general partners' pursuit of target companies subject to significant information asymmetries in light of additional opportunities of unrealized value potential. Various academics (Sahlmann, 1990; Gompers & Lerner, What Drives Venture Capital Fundraising?, 1998; Wright & Robbie, 1998; Cumming & Johan, 2008) argue that such instances of significant information imbalances result in favorable chances for general partners to "mitigate these information asymmetries" (Sommer, 2010, p. 36). In reliance on Oxman & Yildirim (2006) as well as Matthews, Bye & Howland (2009), Sommer (2010, p. 36) noted that "typical buyout candidates run fairly mature businesses with a proven business model and stable cash flows", and hence, are exposed to information asymmetry to a lesser extent. Eventually, Sommer (2010, p. 38) concludes that the implications of information asymmetries from a value-add view perspective is contrasting to the adverse selection cost perspective.

2.3.3 Agency theory

The agency theory suggests that general partners favor higher levels of deal activity due to the typical fee structure as well as to strengthen their track record, the latter especially from a new entrants' perspective. In line with other theoretical concepts, e.g. the information asymmetry concept (see section 2.3.2), the agency theory-based incentives to foster and uphold high levels of deal activity, which accelerates boom phases leading to increased investment activity.

Ross (1973, p. 134) established the agency theory describing the conflicts of interest¹⁹ arising “when one, designated as agent, acts for, on behalf of, or representative for the other, designated the principal, in a particular domain of decision problem”. Unlike the implications of adverse selection due to “hidden information” according to the concept of information asymmetry, the agency theory focuses on “hidden actions”, which result in moral hazards (Amit, Brander, & Zott, 1998, p. 441). Sommer (2010, p. 38 sq.) concluded that for private equity the problems associated with the agency theory are of particular relevance due to “complex legal structures with even more legal entities” as well as the shifts in agency relationships upon the completion of the buyout transaction. In the post-buyout situation, limited partners are not only exposed to agency conflicts towards the general partner but also towards the management of the target company.

In the pre-buyout phase, general partners are confronted with adverse selection issues as described in section 2.3.2. Sahlmann (1990, p. 493) argues that while the general partners’ role as financial intermediary decreases issues in connection with adverse selection, the principal-agent relationship with limited partners results in additional problems. Firstly, the fee structure entailing performance fees incentivizes general partners to accept additional risks, which potentially result in capital losses of limited partners (Sahlmann, 1990, p. 496). Secondly, Müller (2008, p. 28) identified the interest of general partners to target little known industries or asset classes in the pursuit of additional knowledge and for track record purposes outside already served asset classes. Thirdly, Sommer (2010, p. 42) noted in reliance on findings from Fenn et al. (1998, p. 35) that general partners with parallel-running funds may face conflicts of interest resulting in them neglecting “target screening and selection activities” for certain funds due to focusing on “fundraising and monitoring” of others.

In the post-buyout phase, the general partner’s role transforms to a controlling body of the target company (Acharya, Hahn, & Kehoe, 2009, p. 1). Academia offers a wide body of literature regarding the reduction of agency costs arising from buyout transactions by means of robust monitoring frameworks and policies on incentives (Jensen M. C., 1989, p. 7; Jensen M. C., 1991; Gou, Hotchkiss, & Song, 2009, pp. 1-4; Acharya, Hahn, & Kehoe, 2009, p. 1). Jensen (1989, p. 7) argues that general partners effectively reduce agency costs by means of stringent capital policies imposed on target companies, among others, due to the high levels of leverage of such transactions, active participation in the

¹⁹ Jensen and Meckling (2000) found that management acting as an agent has incentives around the pursuit of personal benefits contradicting with the owner’s interests and at the expense of latter’s wealth.

management of target companies and close supervision. These claims were supported by empirical evidence from Kaplan & Strömberg (2003). However, similar to the pre-buyout phase the risk of neglected monitoring efforts and general partners' willingness to accept higher risk considering the fee structure were identified to remain of high relevance by Gompers & Lerner (1996, pp. 464, 480). For example, Sommer (2010, p. 44) claims that the latter can be caused by general partners' pursuit of "risky operational strategies at the target companies" in order to increase the fund's performance potential.

The agency theory in the context of deal and subsequent investment activity is of particular relevance when looking at general partners as pre-buyout owners primarily focus on a high acquisition price and have no incentive to foster high levels of deal activity. Besides the performance fee related incentive to engage in risky transactions, general partners are incentivized to foster high levels of deal activity, among others, due to reputational considerations or lower adverse selection costs (see section 2.3.2). Sahlmann (1990, p. 513) and Jensen (1989) found that a general partner's reputation is crucial looking at vital aspects such as fundraising or robust deal flows. Sommer (2010, p. 45) links a general partner's reputation to their past performance record, hence, argues that the pursuit of a favorable reputation demands numerous successful transactions in order to present "an established investment track record and impressive realized fund performance" to investors. Ramón & Pellón (2003, p. 16) support this claim regarding the interlinkage between invested capital and a general partner's reputation and ability to raise follow-on funds. Despite Fenn et al.'s (1998, p. 37) claim that lacking "reputational capital" might advise new entrants not to pursue high-risk transactions, a wide body of literature agrees on new entrants' high pressure to establish an investment track record with less sensitivity to market conditions (Ljungqvist, Richardson, & Wolfenzon, 2008), and eventually, resulting in relative underperformance compared to established general partners (Gottschlag & Phalippou, 2009). For further performance-related considerations, reference is made to section 2.3.5.

2.3.4 Market timing theory

The market timing theory suggests that investment activity may upsurge or decline based on the extrapolation of past performance, hence, inherently accelerate boom or bust cycles.

Derived from behavioral finance reasoning, market timing theory suggests the possibility of “market participant’s exploitation of temporary misvaluations on capital markets” (Sommer, 2010, p. 52). Defendants of the market timing reasoning argue that other theories, for example Myers & Majluf’s (1984) pecking order theory (see section 2.3.2), fall short of a comprehensive reasoning on why equity issuances are preferred when stock price levels are rising (Lowry, 2003, p. 14; Shleifer & Vishny, *Stock Market Driven Acquisitions*, 2003). Baker & Wurgler (2002, p. 4) find the market timing theory to be divided into two strands of literature, one assuming rational investors and management and another arguing for irrational underestimation of the adverse selection problem leading to issuance of overvalued equity. As explained in section 2.3.2, rational managers are expected to consider information asymmetries and corresponding adverse selection costs when issuing equity (Myers & Majluf, 1984). Due to findings from Minsky (1992) and Sommer’ (2010) assessment thereof in a similar context as present in this paper, irrational behavior is neglected by the author assessing market timing implications on investment activity.

Despite a relatively wide body of literature being dedicated to “boom and bust cycles”²⁰, only few attempted to explain such private equity wave patterns, particularly the link to the market timing theory was neglected due to focuses on the influence arising from agency reasoning, for example by Jensen (1991, p. 26). Kaplan & Stein (1993, p. 348) on the other hand derived private equity pattern explanations from capital and liquidity situations noting temporary liquidity upsurges leading to higher levels of competition for transactions. Similarly, Acharya et al. (2007) suggest that boom and bust cycles are more likely to be caused by lenders rather than overacting general partners or limited partners. They argue that lending overreactions are not triggered by irrational behavior but can be traced back to the complexity of contractual relationships arising from debt syndication. Kaplan & Stein (1993, p. 316), however, argue that the boom and bust cycles are caused by “demand push” as private equity investors seize arbitrage opportunities from temporarily misprices debt and equity markets. Given their findings of abnormal spread behavior during recent boom phases, one may question the efficiency of private equity markets considering Fama’s (1970, p. 387) efficient market hypothesis. Compared to public equity markets, the private equity market shows only weak compliance with the efficient market hypothesis (Sommer, 2010, pp. 56-57). On the other hand, Fama (1970, p. 388) stated that – even if principles of the efficient market hypotheses are violated –

²⁰ Sommer (2010, p. 55) found that the term “boom and bust cycles” stems from Michael C. Jensen.

“the market may be efficient if “sufficient numbers” of investors have ready access to available information”. Further, principle breaches can also be potential sources of inefficiencies and not imply market inefficiency per se.

Sommer (2010, p. 57) noted that a vast body of industry observers identified that general partners paid “premiums over market levels” in boom phases. However, Fama’s (1970) efficient market hypothesis foresees only predictable anomalies to imply market inefficiencies, whereas random market over- and underreactions, which is the case for boom and bust cycles, are consistent with the efficient market hypothesis. Additionally, academia’s disagreement (Kaplan & Schoar, 2005; Acharya, Franks, & Servaes, 2007; Lerner & Wongsunwai, 2007; Gompers, Kovner, Lerner, & Schrfstein, 2008) on whether transactions, which have been closed during boom cycles, out- or underperform constitutes in additional difficulties to assess the rationality of investment decisions. Lastly, Sommer (2010, p. 58) argues that the expectations of limited partners towards general partners to conduct solely in attractive buyout transactions proves judgement difficult to assess whether poorly performing investments were caused by irrational expectations or due to a misalignment of incentives, i.e. principle-agent conflict. The findings from Axelson, Jenkinson, Strömberg & Weisbach (2007, p. 3) that general partners hesitated to invest all committed capital during the recent boom cycle hint that private equity firms are not willing to close transactions “at any price”. Hence, the market timing theory’s “irrationality” component is not subject to any further examination as part of this study following suit Sommer’s (2010) conclusion.

2.3.5 Relationship between investment activity and performance of private equity markets

This section is concerned with the relationship of performance relative to investment activity. Compared to private equity performance relative to public markets and the existence and persistence across time and follow-on funds, only few academics have assessed the link between performance and investment activity within private equity markets and the cyclicalities, thereof. Among the first academics, Kaplan & Schoar (2005) assessed performance in the context of the private equity market cycles. They noted that as private equity funds being raised during boom phases seem to be less likely to secure funding for follow-on funds, they tend to deliver disappointing distributions to investors. The finding on the inverse relationship between fundraising and following vintage year

returns was reaffirmed by Kaplan & Strömberg (2008). Consistent with these findings, Kaplan & Strömberg (2008) as well as Lerner & Wongsunwai (2007) noted that funds raised during boom phases disclosed significant underperformance. Among other factors, this may be caused by imbalance of high levels of dry powder and only limited investment opportunities resulting in overpayments by general partners (Jensen M. C., 1991, p. 27). Similarly, Kaplan & Stein (1993, p. 348) found that in “overheated” markets, transactions are increasingly reckless, and due to the limited amount of high-potential target companies, higher levels of underperforming transactions were observed. Further, Kaplan & Schoar (2005) found that while performance seemed to be positively correlating with a general partner’s experience and the fund’s size, the latter relation was identified to be concave. Regarding the concavity of the performance and fund size relationship, Phalippou & Gottschlag (2008) found no such evidence, however, they noted that inexperienced private equity firms achieve lower performance in general. Similarly, Kaplan & Schoar (2005) noted that “mediocre performing general partners grow proportionally faster than the top general partners”. Among others, Chung, Sensory, Stern & Weisbach (2010) provided further evidence that low performing funds struggle to raise follow-on funds, hence, this suggests that following boom phases fewer underperforming funds participate in the private equity market. Consequently, it can be concluded that the increase in investment activity initially leads to lower performance. However, after a certain period, the identification of which is the aim of this paper, private equity performance is expected to upsurge again.

2.3.6 Synopsis of theoretical framework

Based on the detailed elaborations made in the preceding sections regarding the relevant theoretical framework describing potential interlinkages between the public and private equity market as well as between the investment activity and performance, Figure 6 depicts an illustrative overview of these relationships. The illustration leverages findings from Sommer (2010, p. 59) regarding enforcing (+) and reverse (-) impact of the individual relationships.

In addition, Figure 6 illustrates the theories’ reasoning from the two basic perspectives “fundamentals” and “behavior”. As noted by Sommer (2010, p. 27) and set out in the preceding sections, the neoclassical reasoning assumes (i) investors to act rational, information transparency among them, and their goal to maximize their wealth; and (ii)

validity of economic fundamentals (Weintraub, 1993, p. 2). On the other hand, the market timing theory is considered to follow the (rational)²¹ behavioral perspective.

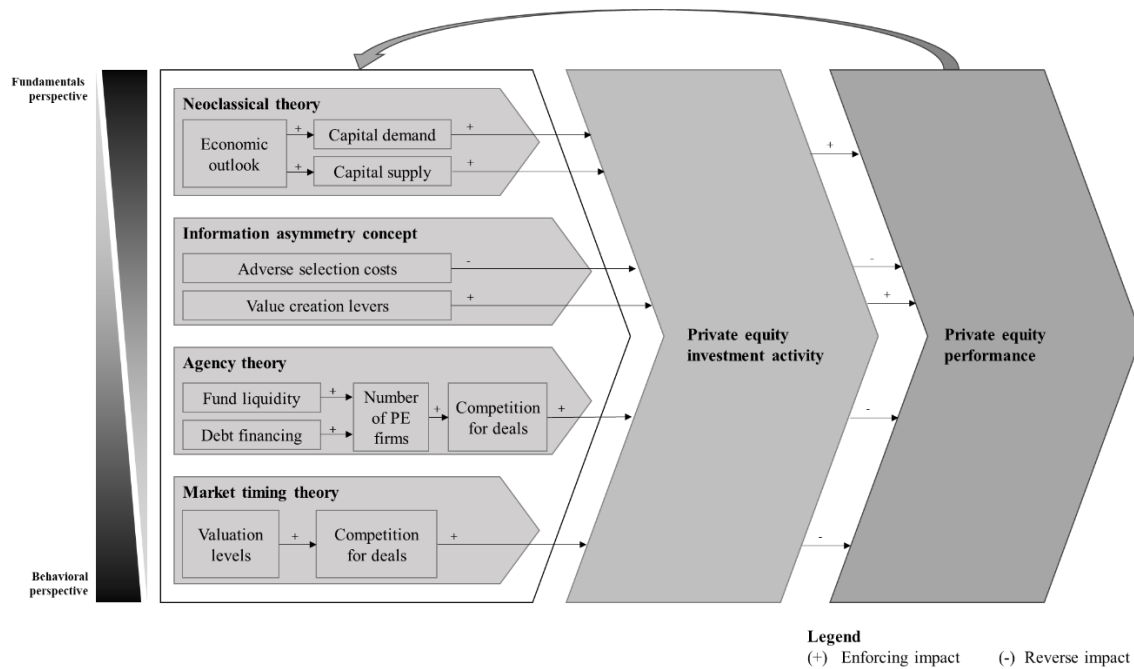


Figure 6: Theoretical framework for drivers of private equity investments and their synopsis

Similarly, to Sommer (2010, p. 62), the author concludes that the different theories are not considered to be mutually exclusive, i.e. may contribute in combination to a better understanding of private equity wave patterns.

²¹ In reliance on Minsky's (1992) findings, the market timing theory was examined considering rational behavior only as academics found explanations to boom and bust cycles considering rational behavior of investors only.

3 Data and methodology

This section describes the data used for the empirical analysis. First, the data source and data collection process are outlined. Second, descriptive statistics of the data are presented.

3.1 Data

The data for this study was obtained from Preqin. The provided data set²² consists of cash flow data of 801 buyout private equity funds (vintage years 1990 until 2013²³). Besides cash flow data, which is divided into the sub-categories “Capital Call”, “Distribution” and “Value”²⁴, other fund data such as target fund size, geographical fund focus and industry of the investments within the portfolio are captured.

Preqin collects data via various sources, the most important ones being: (i) performance data from US and UK institutional investors (via Freedom of Information Act requests); (ii) performance figures from over 2,000 fund managers directly; as well as (iii) other data sources (e.g. annual reports, regulatory / public filings or (interim) financial reports). Data contributors are instructed by Preqin on format as well as what calculation methodologies employed. Data submissions are subject to internal reviews and cross-referencing procedures (e.g. benchmarking and consistency checks with other sources for the same fund). Chung (2012, pp. 2-3) found that Preqin offers “more comprehensive coverage than other commercially available databases”.

3.2 Descriptive statistics

In the following, key characteristics²⁵ of the data set described in section 3.1 are depicted from the perspective of investment activity (refer to section 3.2.1), (vintage year) performance (refer to section 3.2.2) and other characteristics of the data (refer to section 3.2.3).

²² The data set provided by Preqin is attached to this study as disclosed in section 7.

²³ In terms of actuality of the data set, one shall bear in mind that buyout funds with the vintage year 2013, for example, have an average lifespan until 2023, considering findings from Mostowfi & Meier (2013, p. 175).

²⁴ Value = “Estimated net asset value of the fund portfolio” (Preqin Limited, 2018, p. 14)

²⁵ The dataset in its raw form (see section 3.1) was manipulated using Excel VBA scripts and other formulas (for performance characteristics refer to the equations described in section 2.1.3). This “manipulated dataset” served then as input for the empirical analysis as described in section 4. For a copy of the “manipulated dataset”, refer to section 7.

3.2.1 Investment activity

This section provides an overview of observed investment activity in the data set considering the measures employed as described in section 2.1.3. The industry wave patterns, among others, considering investment activity are discussed in section 2.2. These private equity boom phases are – excluding the first boom wave during the junk bond era, which came to an abrupt ending in 1989 – descriptive of the examined data set as well. As such, the second buyout wave ending 1999/2000 as described by Acharya et al. (2007, p. 1) is recognizable in Figures 7 to 9. Likewise, the third buyout wave, the so-called “Golden Age of Private Equity” (Reuters, 2007), during the 2000s prior to the global financial crisis is clearly visible in Figures 7 to 9.

Capital called per vintage year in mn USD

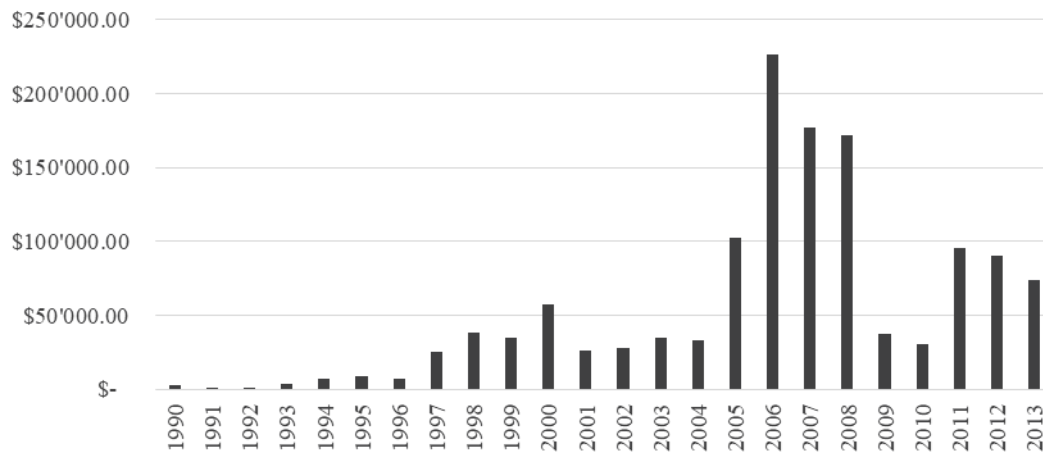


Figure 7: Capital called per vintage year

Fundraising as depicted in Figure 8 indicates the forward-looking investors' confidence into the private equity market. Following boom phases (detailed descriptions made in section 2.2) fundraising slowed down, however, after the second boom wave investment levels remained more or less stable and investors quickly increased capital commitments again in light of the third buyout wave. Similarly fast was the recovered trust into general partners after the financial crisis, which is evidenced by the rapid and significant increase in capital commitments from 2010 onwards.

Private equity funds raised per vintage year

number of funds

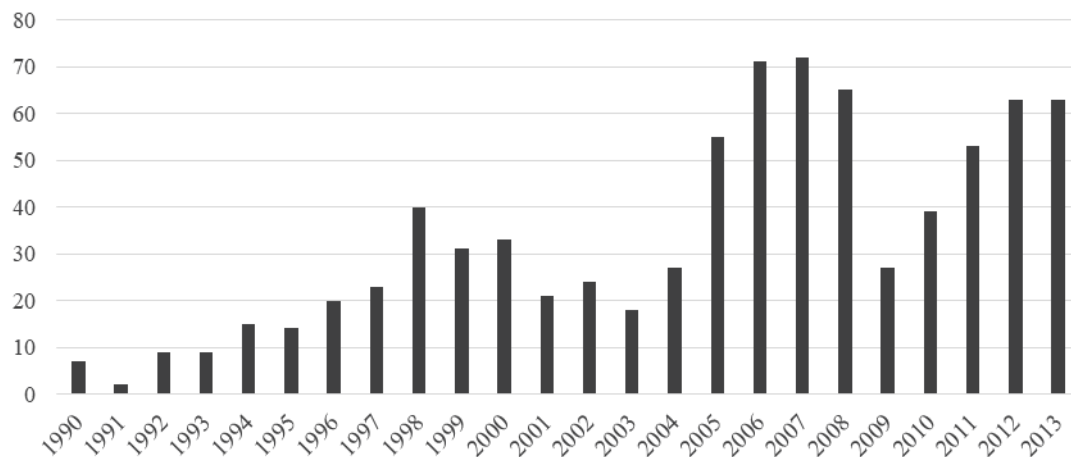


Figure 8: Private equity funds raised per vintage year

The new entrants quota as well as the absolute count of general partners launching their first buyout fund as depicted in Figure 9 strongly correlates with the buyout boom waves as described in section 2.2 and in line with findings, among others, from Kaplan & Schoar (2005). Additionally, Figure 9 depicts the average from all vintage year's funds in terms of their sequence rank, i.e. how many funds a general partner already raised on average, including the fund of the respective vintage year.

New entrants per vintage year

number of fund companies with their first fund

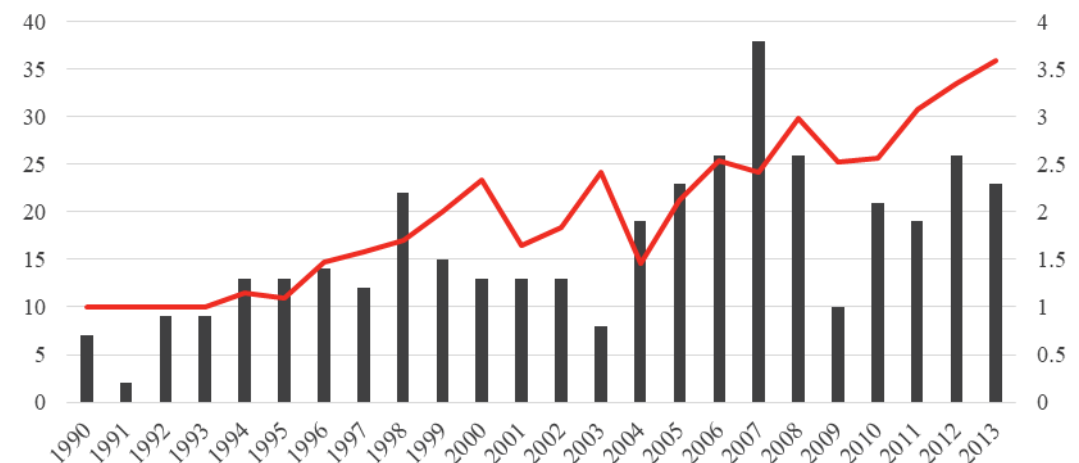


Figure 9: New entrants per vintage year

3.2.2 Performance

Similar to investment activity as described in section 3.2.1, performance measures, namely DPI and IRR for liquidated funds²⁶, are affected by the wave patterns identified. Figures 10 and 11, depict the data set's reaffirmation of findings from Kaplan & Strömberg (2008) and Lerner & Wongsunwai (2007) that increasing capital commitments during boom waves lead to lower fund performance.

Performance of liquidated funds per vintage year
average IRR performance per quartile

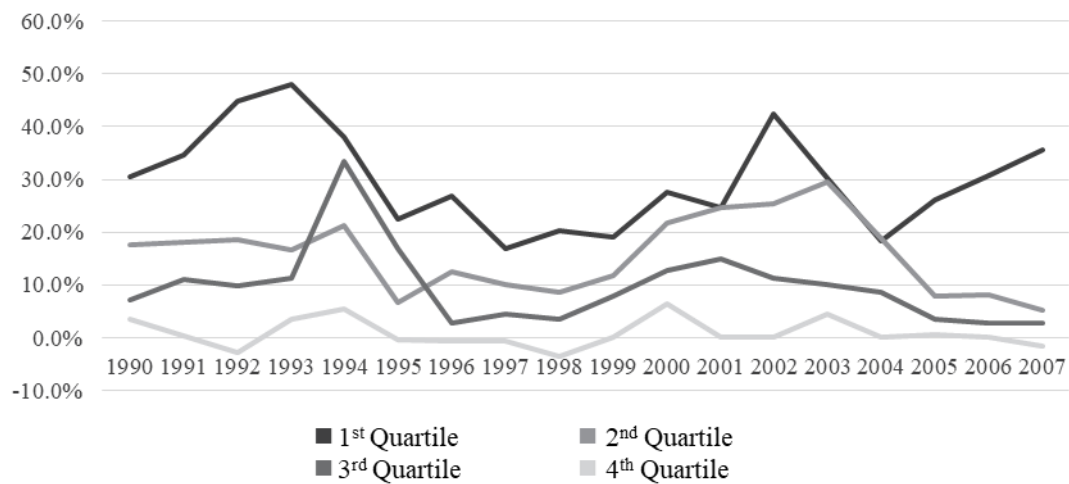


Figure 10: Performance (IRR) of liquidated funds per vintage year

Performance of liquidated funds per vintage year
average DPI performance per quartile

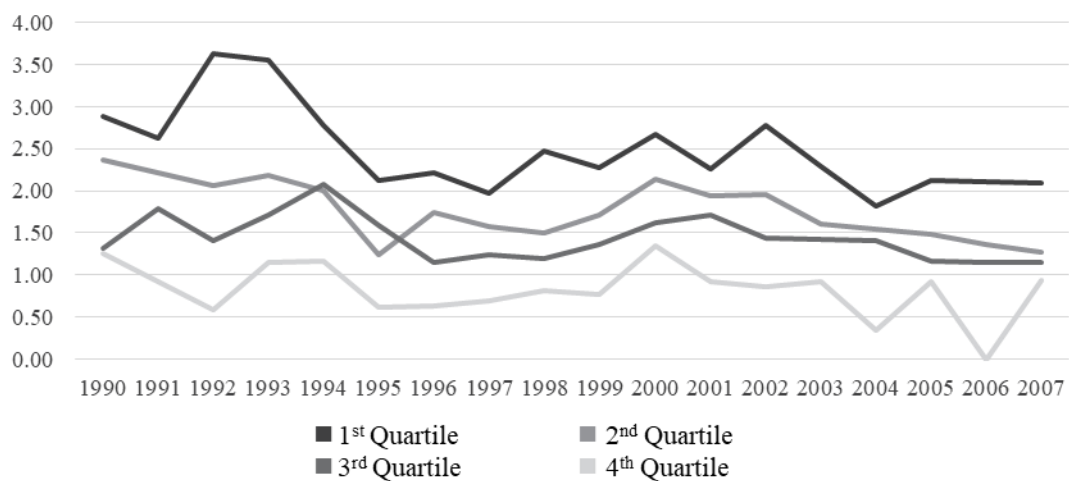


Figure 11: Performance (DPI) of liquidated funds per vintage year

²⁶ As buyout funds raised in more recent vintage years than 2007 are mostly still open, DPI and IRR performance illustrations (see Figures 10 and 11) were limited to 1990 – 2007.

3.2.3 Other characteristics of the data

Geographical fund focuses (as depicted in Figure 12) and fundraising levels broken down into quartiles (as depicted in Figure 13) provide additional insights of the data set examined and are in line with comprehensive industry reports (Bain & Company, Inc. , 2019; Preqin Limited, 2018). Figure 12 highlights the significantly higher size of the North American and European private equity market. In contrast to Figure 1, the Asian private equity market between 1990 and 2013 did not yet experience its recent China-driven growth, strongly influencing aggregated capital raised in Asia.

Geographical focus of funds in the dataset
weighting according to fund sizes

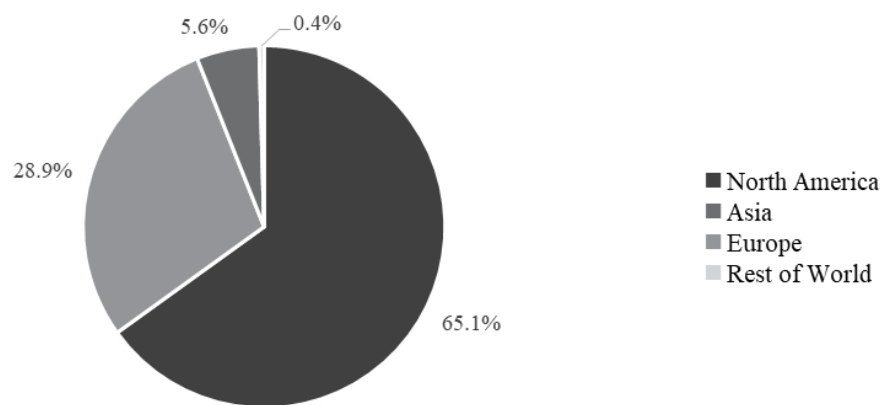


Figure 12: Geographical focus of funds in the data set

Further, Figure 13 depicts scarcity of 1st quartile buyout funds, which provides further reaffirmation to findings from Kaplan & Schoar (2005) on the concavity of the relationship between fund size and performance.

Fundraising per vintage year
in mn USD

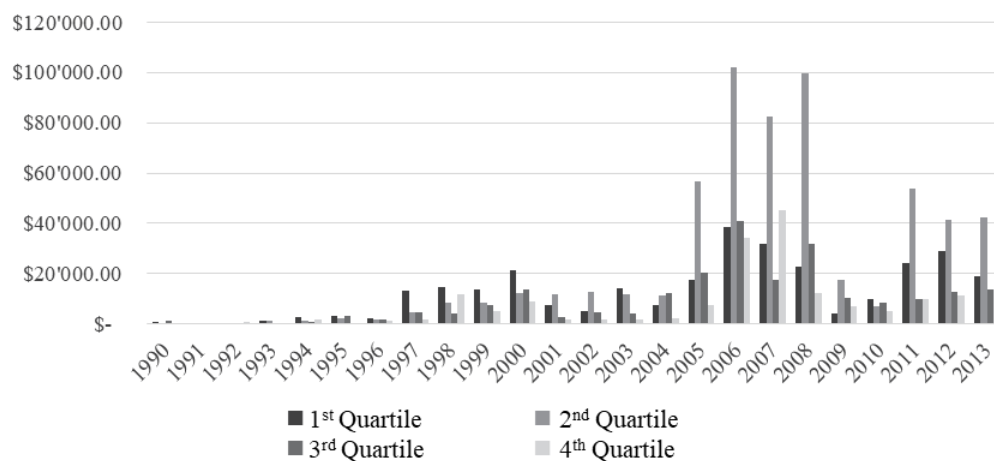


Figure 13: Fundraising per vintage year

3.3 Methodology

Using the cash flow data provided by Preqin (see section 3.1) the relevant performance measures (see section 2.1.3) were calculated for all buyout funds. For comparability purposes, for all liquidated funds²⁷ the performance measures DPI and IRR were used; for all open funds RVPI and TVPI were used. As the vintage years 1990 – 1993 were represented with fewer than 10 funds per vintage year, these four sample periods were consolidated for the empirical testing. Despite the already allocated quartile classification by the data provider, Preqin, a separate quartile determination was conducted. Initially, three quartile determination methods were assessed including their alignment to the nominal distribution. As a result of this preliminary assessment, the quartile determination was conducted based on all four performance measures per fund considering the entire sample population per vintage year (liquidated and open funds), as the nominal distribution fitting of the method segregating liquidated and open funds as well as the approach considering the average of these two approaches revealed a misleading quartile distribution.

Based on the empirical testing approach as described in section 4.1, public market data is required in addition to the provided cash flow data set. In this regard, all relevant public market data required to assess the public market proxies' predictive power on following investment activity was directly extracted from Bloomberg. As the study is limited to US private equity buyout funds, the relevant public market was identified to be represented by the S&P 500 Index. This index is “considered to be a proxy of the US equity market” (S&P Dow Jones Indices, 2019, p. 3). Most public market proxies that were analyzed as part of this study, were consequently derived from the aggregated S&P 500 Index values (e.g. for the operating margin). Where necessary, other publicly available sources were used, for example US GDP data was directly obtained from reports issued by the US Federal Reserve System (“Fed”). In section 4.1.2, the source for each public market proxy is disclosed.

Further, the empirical analysis (as described in section 4) is mainly based on correlation analyses. In this paper, it was relied on the Spearman correlation, a “[robust and] widely used nonparametric measure of correlation” (Croux & Dehon, 2010). Based on the empirical analysis setup, the Spearman correlation offers a better fit, for example

²⁷ Funds, whose residual value is below 5% of the capital called measures, were treated as liquidated funds as with this threshold the performance metrics DPI and IRR showed robust results (and their superior usefulness compared to TVPI and RVPI, which are both subject to general partner estimations on the residual portfolio value).

compared to the Pearson's correlation coefficient, due to its measurement of two variable's relationship (Hauke & Kossowski, 2011). Further, the Spearman correlation measuring the monotonicity of a data set's variables, is frequently used in similar research approaches as followed by this paper, for example Armstrong et al.'s (2006) analysis of the relationship between private and public equity market valuations. Given all testing procedures being conducted within MATLAB®²⁸, the equation coded therein is depicted in Equation 5 derived from the official MATLAB® Statistics and Machine Learning Toolbox™ User's Guide (The MathWorks, Inc., 2019, pp. 32-1103):

Equation 5: Spearman's Rho equation used in MATLAB

$$rho(a, b) = 1 - \frac{6 \sum d^2}{n(n^2 - 1)}$$

“where, d is the difference between the ranks of the two columns, and n is the length of each column” (The MathWorks, Inc., 2019, pp. 32-1104). For mentioned columns in respective matrices the following Equation 6 is defined in MATLAB® (The MathWorks, Inc., 2019, pp. 32-1103):

Equation 6: Means of columns X_a and Y_b in their respective matrices

$$\bar{X}_a = \sum_{i=1}^n \frac{(X_{a,i})}{n} / \bar{Y}_b = \sum_{j=1}^n \frac{(Y_{b,j})}{n}$$

²⁸ MATLAB® automatically computes the p-value of each corresponding element of Spearman rho. Correlations are deemed significant if the p-value is below 0.05. The rank correlation function in MATLAB® is coded according to generally accepted mathematical standards established by Gibbons (1985), Hollander & Wolfe (1973), Kendall (1970) and Best & Roberts (1975).

4 Empirical analysis

4.1 Introduction

In the following, the development of this paper's hypotheses and proxies employed is described considering elaborations made in section 2.3. Reference is made to Figure 6, which outlines the synopsis of the theoretical framework considering the relationship between (i) public and private equity markets; and (ii) the investment activities implications on the performance of private equity funds.

4.1.1 Development of hypotheses

In the following, the three hypotheses serving as the fundament to this paper's empirical analysis are developed. Figure 14 depicts an illustration of the three hypotheses following the synopsis of the theoretical framework as presented in Figure 6:

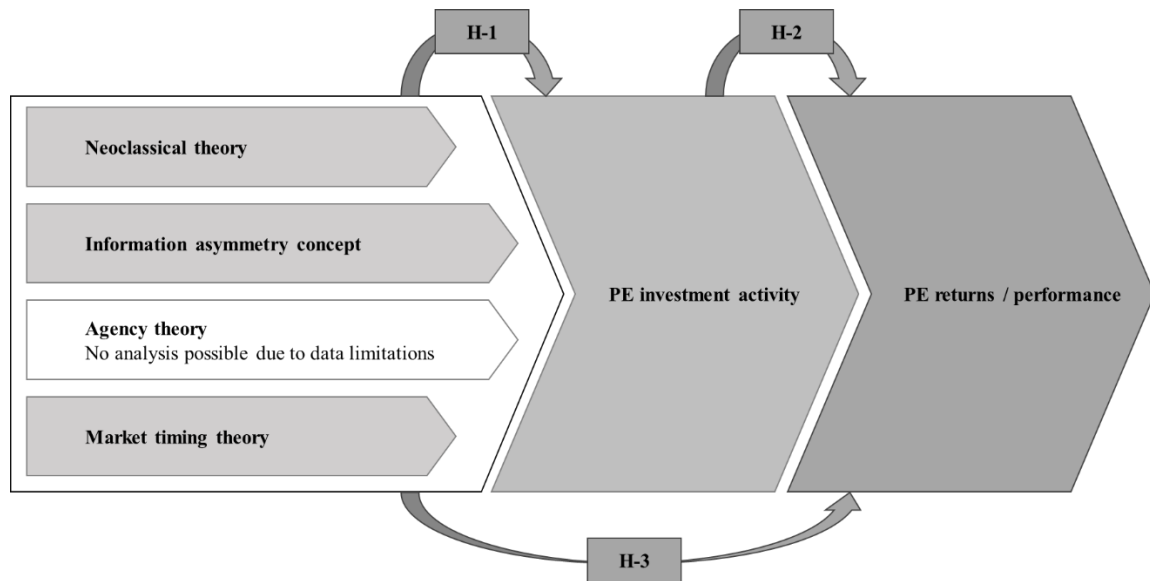


Figure 14: Illustration of the paper's hypotheses

Firstly, Hypothesis H-1 follows the theoretical framework as described in sections 2.3.1 until 2.3.4. As such, the four theories possibly impacting investment activity considering Sommer's (2010) findings are the (i) neoclassical theory; (ii) information asymmetry concept; (iii) agency theory; and (iv) market timing theory. Neoclassical reasoning suggests that with increasingly favorable economic indicators investment activity is expected to upsurge. From an information asymmetry perspective, two contradicting theories were discussed, based on findings from Sommer (2010, p. 203) for buyout funds the "adverse selection costs" seem to be predominant, hence, less information imbalance is considered favorable and leading to higher levels of investment activity. The agency

theory suggests that general partners are incentivized to foster and uphold high levels of deal activity, which accelerates boom phases leading to increased investment activity. However, as set out in section 4.1.2, due to the available data set on fund-level no adequate proxies can be derived to test the possible correlation between agency theory-based proxies with investment activity. From a market timing perspective²⁹, investment activity is likely to upsurge due to the extrapolation of prosperous past performance. In terms of the proxy development measuring shifts according to these concepts, reference is made to section 4.1.2. Consequently, the following hypothesis is derived:

H-1: More prosperous public market proxies – taking into consideration the neoclassical theory, the information asymmetry concept and the market timing theory – lead to a time-lagged increase in investment activity (public and private equity market relation hypothesis).

Secondly, Hypothesis H-2 follows the theoretical framework as described in section 2.3.5. As such, it was noted that based on findings from Kaplan & Schoar (2005) considering various confirming studies (Kaplan & Strömberg, 2008; Lerner & Wongsunwai, 2007; Phalippou & Gottschalg, 2008; Chung, Sensoy, Stern, & Weisbach, 2010) that (i) initially higher levels of investment activity lead to lower performance; and (ii) performance is expected to upsurge again after a certain period of time. Consequently, the following hypothesis is derived:

H-2: Increase in investment activity leads to a time-lagged upsurge in private equity performance (investment activity and performance relation hypothesis).

Thirdly, Hypothesis H-3 is constructed as a robustness and control test of hypotheses H-1 and H-2. Besides the basic confirmation of significant correlations as per the preceding hypotheses descriptions, separate time lags will be computed. This third hypothesis is designed to assess the validity of the accumulation of these separate time lags by directly testing the time-lag between the relevant public proxies to the performance measures. This testing principle is illustrated in Figure 14. Consequently, the following hypothesis is derived:

²⁹ As per section 2.3.4 irrational behavior is neglected in the analysis of the market timing theories' implications on investment activity and prediction of subsequent private equity performance.

H-3: The accumulated time lag identified as a result of H-1 and H-2 can be verified by directly assessing the time-lag between more prosperous public market proxies an up surging private equity performance (control and robustness test hypothesis).

4.1.2 Development of public market proxies

In the following, the proxies measuring the public market's characteristics on an aggregated level are developed to identify improving public market levels and their time lag to investment activity and private equity performance as exemplary depicted in Figure 15. The proxy development leverages from Sommer's (2012) comprehensive research in this matter. The different proxies representing aggregated financial data can be categorizes as company-level data (aggregated on S&P 500 Index-level), macroeconomic metrics and other financial market data. In Tables 1 and 2, the public market proxies used in this study are listed and grouped according to the corresponding theories as elaborated in section 2.3.

Based on the neoclassical view (see section 2.3.1), proxies for the three key concepts: (a) economic shocks; (b) capital demand; and (c) capital supply were defined. In reliance on research conducted by Sommer (2012, pp. 111-113), economic shock proxies were developed according to a wide body of literature addressing economic conditions. Besides the GDP (Leachman, Kumar, & Orleck, 2002, p. 28; Deb & Mukherjee, 2008), the Organisation for Economic Co-operation and Development's ("OECD") business confidence index³⁰ was selected in order to assess the influence of economic conditions on financing decisions (Choe, Masulis, & Nanda, 1993; Dutordoir & van der Gucht, 2007; Rau & Stouraitis, 2010). Sommer (2012, p.111) described the operating and profit margin to be influenced by economic shocks, hence, this study follows other academics (Mitchell & Mulherin, 1996; Lowry, 2003, p. 14; Harford, 2005) in the assumption that these are leading proxies to subsequent changes in investment activity. In addition – and not reflecting any particular theoretical implications – the sales, earnings and cash flow per share ratios were investigated as well considering their respective inherent characteristics and importance to financial analysts and investors alike.

³⁰ Abberger (2004) found that the OECD's business confidence index indicated the apprehended business prospects.

In terms of capital demand, capital expenditures and total assets are considered to provide indirect insights of companies' investment behavior (Sommer, 2012, p. 112). Further, Sommer (2012, p. 112) concluded that they "gauge the availability and use of financial funds". The capital demand proxies employed in this study reflect similar approaches observable in research conducted by other academics (Mitchell & Mulherin, 1996; Harford, 2005; Rau & Stouraitis, 2010; Lowry, 2003).

Additionally, three proxies were developed to measure capital supply, which may be available to fund private equity deals: (i) outstanding corporate debt; (ii) corporate high-yield index; and (iii) London Inter-bank Offered Rate ("LIBOR") interest rates. Kaplan & Strömberg (2009) concluded that buyout transactions are significantly financed using high-yield vehicles. Sommer (2012, p. 113) associated domestic debt indexes to "measure overall liquidity in the bank lending market". Lastly, the LIBOR-based proxy is intended to represent the cost of borrowing, in a similar way as the Euro Interbank Offered Rate ("EURIBOR") as investigated by Axelson et al. (2007) while better fitting the US focus of the empirical analysis.

Based on the concept of information asymmetry (see section 2.3.2), three proxies were identified to capture the issues associated therewith. Firstly, trading volume was selected as a proxy for information imbalances following the reasoning discussed in various research (Easley, Kiefer, O'Hara, & Paperman, 1996; Easley, Hvidkjaer, & O'Hara, 2002) that generally investors without non-public information outnumber investors in possession of such. Secondly, the well-researched matter of information asymmetries in connection with dividend payments, which was theoretically established by Modigliani & Miller (1958), Miller & Rock (1985) and Williams & John (1985) and empirically evidenced by Zhao & Li (2008), led to the consideration of the price-to-book ratio from non-dividend paying companies and the spread of this metric between dividend and non-dividend distributing companies. The latter also captures market timing considerations. Additionally, Sommer (2012, pp. 116-117) raises valid concerns regarding the robustness of dividend-related proxies given academia's ongoing debate on dividend policy theories. Consequently, the author concludes in consideration of Baker (2009), Baker & Wurgler (2004a; 2004b) and Baker & Wurgler (2007) that while dividend-related proxies can embody predictive characteristics, they should be in line and reaffirmed by other public market proxies.

Regarding the agency conflict proxies, the research approach from Sommer (2012) was investigated. Given Sommer's (2012, pp. 163-164) findings on the agency theory hypotheses assessing predictive drivers at aggregated levels and the difficulty to identify suitable proxies properly reflecting the theoretical concepts set forth in section 2.3.3, it was refrained from developing proxies in this regard. This decision is also driven by limitations of the data set, which does not allow for an adequate re-assessment of Sommer's (2012) findings.

Based on the market timing theory (see section 2.3.4), three proxies were identified to capture the issues associated therewith. Firstly, the price-to-book ratio, which relates a company's market value in terms of its book value, enables the identification of arbitrage opportunities due to misevaluation or other market timing considerations (Baker & Wurgler, 2002; Jensen M. C., 2004; Schmidt, Nowak, & Knigge, 2004; Alti, 2006; Rau & Stouraitis, 2010). Secondly, Lowry (2003, p. 14), Alti (2006) and Baker & Wurgler (2007) concluded that the IPO volume allows for market timing evaluation concerning equity issuances. Based on similar reasoning, the author included the count of IPO deals as an additional proxy in this regard. Thirdly, the spread between high-yield and AAA-rated corporate bonds was developed as another proxy due to its characterization of debt issuance-concerned market timing opportunities.

Further, it was noted during the discussion of the theoretical framework (section 2.3) that the different concepts are not mutually exclusive. Consequently, additional company-related proxies (e.g. debt-to-equity ratio), which embody similar characteristics as above-mentioned ones, particularly concerning the neoclassical view, were included in the empirical analysis as well. Among others, this is due to the reasoning that while the wave patterns of private equity cycles have been established but not yet fully explained from theoretical standpoints, other key metrics frequently used by analysts and investors alike might affect their investment decisions as well. For an overview of all other company-related proxies subject to the empirical analysis, reference is made to Table 2.

Public market proxy	Description / Source	Prediction, according to Sommer (2010)
<i>Economic shock proxies</i>		
GDP	GDP of the United States of America; Source: Fed-Bank of St. Louis (2019)	-
Industrial Production	Fed report “Industrial Production and Capacity Utilization – G.17”; Source: Fed (2019).	-
Business Confidence Index	Business Confidence Index for the US; Source: OECD (2019)	~
Operating margin	S&P 500 Index value of therein captured companies’ operating margin; Source: Bloomberg (2019a).	+
Profit margin	S&P 500 Index value of therein captured companies’ profit margin; Source: Bloomberg (2019b).	+
Sales per share	S&P 500 Index value of therein captured companies’ sales per share; Source: Bloomberg (2019c).	+
Earnings per share	S&P 500 Index value of therein captured companies’ earnings per share; Source: Bloomberg (2019d).	+
Cash flow per share	S&P 500 Index value of therein captured companies’ cash flow per share; Source: Bloomberg (2019e).	+
<i>Capital demand proxies</i>		
Capital expenditures	S&P 500 Index value of therein captured companies’ capital expenditures; Source: Bloomberg (2019f).	+
Total assets	S&P 500 Index value of therein captured companies’ total assets; Source: Bloomberg (2019g).	+
<i>Capital supply proxies</i>		
Outstanding corporate debt	Index values of the US Debt Outstanding index (ticker: DOUTCORP); Source: Bloomberg (2019h).	+
US Corporate High-Yield Total Return Index	Index values of the US Corporate High-Yield Total Return Index (ticker: LF98TRUU); Source: Bloomberg (2019i).	+
LIBOR (3- and 12-months)	Three- and twelve-months LIBOR rates – Source: Bloomberg (2019j).	-

The column “Prediction” is based on findings from Sommer (2012) and refers to the theoretical predictive relationship between the respective proxy and investment activity. While “+” represents a relationship of the proxy towards private equity activity, “-” denotes inverse relationships and “~” indicates contradicting elements, which do not allow for a clear determination of the assumed relationship. Note that these predictive relationships are solely based on theoretical assumptions, hence, for relationships, which were identified to have significant correlations, i.e. predictive characteristics, reference is made to section 4.2.

Table 1: Public market proxies (neoclassical theory)

Public market proxy	Description / Source	Prediction, according to Sommer (2010)
<i>Information asymmetry proxies</i>		
Trading volume	S&P 500 Index value of aggregated trading volume; Source: Bloomberg (2019k).	+
Price-to-book ratio (non-dividend only)	S&P 500 Index value of therein captured non-dividend distributing companies' price-to-book ratios; Source: Bloomberg (2019l).	+
Δ Price-to-book ratio (dividend vs. non-dividend)	Calculated spread between (a) S&P 500 Index value of therein captured non-dividend distributing companies' price-to-book ratios; and (b) S&P 500 Index value of therein captured dividend distributing companies' price-to-book ratios; Source: Bloomberg (2019l).	+
<i>Market timing proxies</i>		
Price-to-book ratio	S&P 500 Index value of therein captured companies' price-to-book ratios; Source: Bloomberg (2019l).	~
IPO volume	IPO volume in USD (annualized) in the United States – Source: Bloomberg (2019m).	+
IPO deals	Count of IPOs (annualized) in the United States – Source: Bloomberg (2019n).	~
US Corporate AAA Total Return Index	Index values of the US Corporate AAA Total Return Index (ticker: LU3ATRUU); Source: Bloomberg (2019o).	+
Δ High-Yield to AAA (Total return indices)	Calculated spread between (a) the US Corporate High-Yield Total Return Index (ticker: LF98TRUU); and (b) the US Corporate AAA Total Return Index (ticker: LU3ATRUU); Source: Bloomberg (2019i; 2019o).	+
<i>Other company-related proxies</i>		
Debt-to-equity ratio	S&P 500 Index value of therein captured companies' debt-to-equity ratio; Source: Bloomberg (2019p).	+
Debt-to-EBITDA ratio	S&P 500 Index value of therein captured companies' debt-to-EBITDA ratio; Source: Bloomberg (2019q).	+
Enterprise value-to-sales ratio	S&P 500 Index value of therein captured companies' EV-to-sales ratio; Source: Bloomberg (2019r).	~
Enterprise value-to-EBIT ratio	S&P 500 Index value of therein captured companies' EV-to-EBIT ratio; Source: Bloomberg (2019s).	~
Enterprise value-to-EBITDA ratio	S&P 500 Index value of therein captured companies' EV-to-EBITDA ratio; Source: Bloomberg (2019t).	~
Net dividend yield	S&P 500 Index value of therein captured companies' net dividend yield; Source: Bloomberg (2019u).	~

The column “Prediction” is based on findings from Sommer (2012) and refers to the theoretical predictive relationship between the respective proxy and investment activity. While “+” represents a relationship of the proxy towards private equity activity, “-” denotes inverse relationships and “~” indicates contradicting elements, which do not allow for a clear determination of the assumed relationship. Note that these predictive relationships are solely based on theoretical assumptions, hence, for relationships, which were identified to have significant correlations, i.e. predictive characteristics, reference is made to section 4.2.

Table 2: Public market proxies (other theories)

4.2 Results

In this section, the results of the hypotheses testing are discussed following the structure of the hypothesis and proxy development in sections 4.1.1 and 4.1.2.

Firstly, hypothesis H-1 claimed that more prosperous public markets measured by means of proxies, lead to a time-lagged increase in investment activity. All public market proxies, according to Tables 1 and 2, were tested for their correlation with investment activity from five preceding years (indicative of investment activity leading public market developments) until ten lagging years (indicative of public markets influencing the investment activity)³¹. The investigated timing shifts are based on two assumptions. Firstly, that the private equity market lacks the magnitude to significantly influence the public market (therefore only five (preceding) years were analyzed in order to provide a comprehensive picture while expecting only limited relevance to the time lag estimation). Secondly, the timespan of ten (lagging) years was determined to be appropriate based on the elaborations made on typical boom and bust cycle patterns observable in the past (see section 2.2).

As the result of these comprehensive correlation analyses, time-lagged investment activity increases were noted after upsurging public market proxies reflecting theoretical aspects of the neoclassical reasoning and the concept of information asymmetry. Hereto, reference is made to Table 3, which depicts the summary of all proxies with significant correlation to investment activity. In compliance with Sommer's (2012, p. 163-164) findings, the neoclassical reasoning and economic shock proxies in particular, evidence a strong predictive characteristic in this regard. As discussed in section 4.1.2, dividend-related proxies shall not evidence predictive power of the market timing theory as per academia's ongoing discussion on the underlying theoretical concepts of dividend theories. However, given the results shown in Table 3, dividend-related proxies indicate the same time lag of a bit less than one year as the neoclassical operating and profit margin proxies do. Hence, it is concluded that the neoclassical and market timing theory validate each other in this regard.

³¹ Note that Table 3 depicting the results of these considered timing shifts only considers a relevant extract of all the tested time shifts.

To account of anomalies, correlations with a Spearman rho below 0.6³² regardless of their significance (if significant they are highlighted in *italic* in Table 3) were excluded from further consideration.

Therefore, the following conclusion was derived based on the testing of the hypothesis H-1 as elaborated above in conjunction with the results depicted in Table 3:

H-1: For certain public market proxies derived from the neoclassical theory and the information asymmetry concept a time-lagged increase in investment activity was observed.

Public market proxy	Private equity activity measure	Significant correlations (spearman rho with pval <0.05)					
		+3 years	+2 years	+1 years	no time lag	-1 year	-2 years
Neoclassic theory: economic shock proxies							
Operating margin	Volume	na	0.637	0.870	0.692	na	na
	Amount of funds (#)	na	0.696	0.836	0.716	na	na
	New entrants-ratio	na	-0.632	-0.718	-0.649	-0.570	na
Profit margin	Volume	na	0.615	0.777	0.649	na	na
	Amount of funds (#)	na	0.637	0.819	0.661	na	na
	New entrants-ratio	na	-0.650	-0.654	-0.663	-0.584	na
Neoclassic theory: capital demand proxies							
Capital expenditures	Volume	na	na	0.610	0.802	0.743	0.512
	Amount of funds (#)	na	na	0.633	0.832	0.667	na
	New entrants-ratio	na	-0.588	-0.765	-0.851	-0.697	na
Information asymmetry proxies							
Price-to-book ratio (non-dividend only)	Volume	na	0.650	0.776	0.658	na	na
	Amount of funds (#)	0.514	0.618	0.844	0.726	na	na
	New entrants-ratio	na	-0.641	-0.690	-0.567	-0.577	na
Δ Price-to-book ratio (dividend vs. non-dividend)	Volume	na	0.578	0.762	0.670	0.542	na
	Amount of funds (#)	na	0.547	0.809	0.726	0.540	na
	New entrants-ratio	na	-0.621	-0.759	-0.608	-0.647	-0.518
Time Lag (all correlations)		1%	22%	31%	28%	15%	3%
Time Lag (corrected for anomalies)		0%	25%	35%	32%	8%	0%

Figures highlighted in **bold** indicate the time shift with the strongest correlation. Time lag calculation based on the absolute value of correlations in their sum per time lag category. Correlations below 0.600 or contradictive to the theoretical framework (i.e. inverted) were excluded from the "Time Lag (corrected for anomalies)" and highlighted in *italic font* in the table.

Table 3: Results concerning hypothesis H-1

Secondly, hypothesis H-2 claimed that increasing investment activity leads to a time-lagged upsurge in private equity performance. The performance metrics were not only considered on vintage year level only (indicated with "all quartiles") but also broken down into the different quartile as elaborated in section 3.3. The investment activity

³² Correlations below 0.6 are considered anomalies or potentially misleading results. Given their rather weak meaningfulness, they were excluded entirely. In order to account for the higher importance of very strong correlations (e.g. 0.9) in comparison to weaker yet meaningful correlations (e.g. 0.68), the time lag calculation for this hypothesis followed a weighted computation based on the correlations' absolute values.

measures, were tested for their correlation with performance metrics from five preceding years (indicative of performance levels leading investment activity) until ten lagging years (indicatives of upsurging investment activity influencing the performance levels)³³. The investigated timing shifts are based on elaborations made in section 2.3.5 that during boom cycles performance tends to decline and upsurge again after a certain period of time.

The extensive correlation analysis suggests that higher levels of investment activity leads to time-lagged increases of private equity performance. Thus reaffirming that performance does not immediately increase during boom phases but will only upsurge on an aggregated level if underperforming general partners struggle to raise follow-on funds as described in section 2.3.5. Hereto, reference is made to Table 4, which depicts the summary of all investment activity measures' significant correlations to performance metrics.

In order to account for anomalies, correlations with a Spearman rho below 0.6³⁴ regardless of their significance (if significant they are highlighted in *italic* in Table 4) were excluded from further consideration.

Therefore, the following conclusion was derived based on the testing of the hypothesis H-2 as elaborated above in conjunction with the results depicted in Table 4:

H-2: Increase in investment activity leads to a time-lagged upsurge in private equity performance.

³³ Note that Table 4 depicting the results of these considered timing shifts only considers a relevant extract of all the tested time shifts.

³⁴ Correlations below 0.6 are considered anomalies or potentially misleading results. Given their rather weak meaningfulness, they were excluded entirely. In order to account for the higher importance of very strong correlations (e.g. 0.9) in comparison to weaker yet meaningful correlations (e.g. 0.68), the time lag calculation for this hypothesis followed a weighted computation based on the correlations' absolute values.

Private equity activity measurement	Private equity performance measurement	Significant correlations (spearman rho with pval <0.05)						
		+4 years	+3 years	+2 years	+1 years	no time lag	-1 year	-2 years
Volume	DPI (1st Quartile)	na	-0.5964	-0.7357	-0.5536	na	na	na
	DPI (3rd Quartile)	na	na	-0.6099	-0.6978	na	na	na
	DPI (all Quartiles)	na	na	-0.6285	na	-0.5129	na	na
	IRR (1st Quartile)	na	na	-0.5679	na	na	na	na
	TVPI (1st Quartile)	-0.8737	na	na	na	na	na	na
	TVPI (2nd Quartile)	na	-0.5982	-0.6523	na	na	na	na
	RVPI (1st Quartile)	na	0.5845	0.8501	na	na	na	na
	RVPI (2nd Quartile)	na	na	0.6188	na	na	na	na
Count of funds (#)	DPI (1st Quartile)	na	-0.7619	-0.5937	-0.7247	na	na	na
	DPI (3rd Quartile)	na	na	-0.7137	-0.7718	-0.5537	na	na
	DPI (all Quartiles)	na	na	-0.7205	na	na	na	na
	IRR (1st Quartile)	na	na	-0.5363	na	na	na	na
	TVPI (1st Quartile)	-0.8239	na	na	na	na	na	na
	TVPI (2nd Quartile)	na	na	-0.6038	na	na	na	na
	RVPI (1st Quartile)	0.8938	0.5647	na	na	na	na	na
	RVPI (2nd Quartile)	0.5625	na	na	na	na	na	na
New entrants-ratio	DPI (1st Quartile)		0.5237	0.8643	0.6291	na	na	na
	DPI (2nd Quartile)	na	na	0.6953	0.5607	na	na	na
	DPI (3rd Quartile)	na	na	na	0.7253	na	na	na
	IRR (1st Quartile)	na	na	0.5464	na	na	na	na
	TVPI (2nd Quartile)	na	-0.6343	-0.7056	na	na	na	na
Time Lag (all correlations)		13%	18%	45%	20%	4%	0%	0%
Time Lag (corrected for anomalies)		16%	10%	53%	21%	0%	0%	0%

Figures highlighted in **bold** indicate the time shift with the strongest correlation.
Note that due to the nature of the performance measure (see Equation 4), TVPI correlations are inverse.
Time lag calculation based on the absolute value of correlations in their sum per time lag category.
Correlations below 0.600 or contradictory to the theoretical framework (i.e. inverted) were excluded from the "Time Lag (corrected for anomalies)" and highlighted in *italic font* in the table.

Table 4: Results concerning hypothesis H-2

Thirdly, hypothesis H-3 claimed that the time lags identified as a result of hypotheses H-1 and H-2 can be verified by directly assessing the time lag between the public market proxies and private equity performance. Hence, analog to the testing approach of hypothesis H-1, all public market proxies according to Tables 1 and 2 were tested for their correlation with private equity performance. Again, the correlation analyses were conducted for five preceding years (indicative of private equity performance to have predictive characteristics of improving public market conditions) until ten lagging years (indicating upsurging public markets to influence private equity performance)³⁵. The investigated timing shifts are based on the assumptions made for hypotheses H-1 and H-2. These correlation results are depicted in Table 5.

³⁵ Note that Table 5 depicting the results of these considered timing shifts only considers a relevant extract of all the tested time shifts.

Figure 15 illustrates the correlation results from Table 5 at the example of the public market proxy “operating margin”.

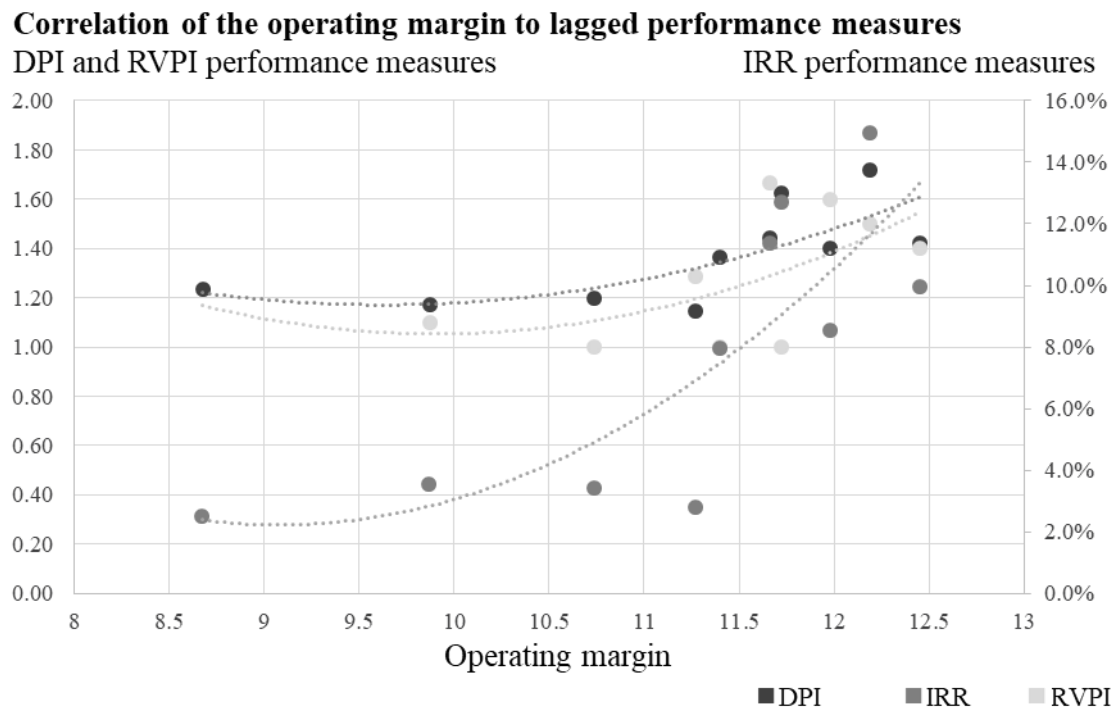


Figure 15: Correlation of the operating margin to lagged performance measures

Given the nature of the exercise to aggregate separate time lags, which are assumed to be sequential, the correlation results shown in Table 5 are subject to additional testing procedures in order to approximate the time-lag. Hence, the separate time lags from hypotheses H-1 and H-2 were cross-multiplied in percentage terms accounting for all possible combinations of these time lags, i.e. perfectly contradictory, parallel-running (neutral) or perfectly sequential. These computations are depicted in Table 6. In Table 6, the correlation results from Table 5 were transformed into percentage values as well (referred to as “control and robustness test”).

Public market proxy	Private equity performance measurement	Significant correlations (spearman rho with pval <0.05)						
		+4 years	+3 years	+2 years	+1 years	no time lag	-1 year	-2 years
Neoclassic theory: economic shock proxies								
Operating margin ³⁶	DPI (3rd Quartile)	0.8000	na	na	na	-0.6823	-0.7527	na
	IRR (3rd Quartile)	0.8833	na	na	na	na	na	na
	RVPI (1st Quartile)	0.5336	na	na	na	na	na	na
Profit margin	DPI (3rd Quartile)	0.9333	na	na	na	-0.7582	-0.7143	na
	DPI (4th Quartile)	na	na	0.5824	na	na	na	na
	IRR (1st Quartile)	na	na	0.5659	na	-0.6357	na	na
	IRR (3rd Quartile)	0.8667	na	na	na	na	na	na
	IRR (all Quartiles)	0.7319	na	na	-0.5245	na	na	na
	RVPI (1st Quartile)	0.5864	na	na	-0.5746	na	na	na
Neoclassic theory: capital demand proxies								
Capital expenditures	DPI (3rd Quartile)	na	0.7091	na	na	na	-0.5714	-0.7692
	IRR (3rd Quartile)	na	0.8667	0.9091	0.5944	na	na	na
	IRR (4th Quartile)	0.7065	0.6409	na	na	na	na	na
	IRR (all Quartiles)	na	0.5679	0.5765	na	na	na	na
	RVPI (3rd Quartile)	0.5812	na	0.5693	0.5827	0.6731	0.7398	0.7917
	RVPI (all Quartiles)	0.6216	0.5258	0.5332	0.5479	0.6511	0.7052	0.7740
	TVPI (3rd Quartile)	-0.5185	na	-0.6237	-0.643	-0.6578	-0.7037	-0.7808
	TVPI (all Quartiles)	na	na	-0.5662	na	na	na	na
Information asymmetry proxies								
Price-to-book ratio (non-dividend only)	IRR (3rd Quartile)	0.8671	0.6593	na	na	na	-0.6758	na
	IRR (all Quartiles)	0.5809	na	na	na	-0.6966	-0.5686	na
	RVPI (1st Quartile)	0.5569	na	na	-0.6957	-0.6972	na	na
	TVPI (4th Quartile)	na	na	-0.656	na	na	na	na
Δ Price-to-book ratio (dividend vs. non-dividend)	DPI (all Quartiles)	na	0.5500	na	na	na	-0.5789	-0.5789
	IRR (3rd Quartile)	na	0.6727	na	na	na	-0.5989	na
	IRR (all Quartiles)	0.7978	na	na	na	-0.6223	-0.5377	-0.5377
	RVPI (4th Quartile)	na	na	na	0.6805	na	na	na
	TVPI (4th Quartile)	na	na	-0.7397	na	na	na	na
Time lag (all correlations)		24%	12%	14%	11%	14%	16%	10%
Time lag (corrected for anomalies)		31%	13%	17%	14%	11%	7%	8%

Figures highlighted in **bold** indicate the time shift with the strongest correlation. Note that due to the nature of the performance measure (see Equation 4), TVPI correlations are inverse. Time lag calculation based on the absolute value of correlations in their sum per time lag category. Correlations below 0.600 or contradictory to the theoretical framework (i.e. inverted) were excluded from the "Time Lag (corrected for anomalies)" and highlighted in *italic font* in the table.

Table 5: Results concerning hypothesis H-3

³⁶ For illustration purposes, the correlation of the proxy „Operating margin“ with the corresponding time lag as shown in Table 5 is depicted in Figure 15.

Time lag: Summary (incl. control and robustness test)		Significant correlations (spearman rho with pval <0.05)						
		+4 years	+3 years	+2 years	+1 years	no time lag	-1 year	-2 years
<i>Neoclassic theory: economic shock proxies</i>								
Operating margin	<i>to private equity activity measurement</i>	0.0%	0.0%	30.5%	37.6%	31.9%	0.0%	0.0%
	<i>to private equity performance measurement</i>	17.4%	7.7%	55.4%	19.6%	0.0%	0.0%	0.0%
	Total time lag (cross-multiplication)	44.3%	30.7%	18.5%	6.5%	0.0%	0.0%	0.0%
	Control and robustness test (public market proxy \Rightarrow private equity performance measurement)	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Profit margin	<i>to private equity activity measurement</i>	0.0%	0.0%	31.1%	36.7%	32.2%	0.0%	0.0%
	<i>to private equity performance measurement</i>	17.4%	7.7%	55.4%	19.6%	0.0%	0.0%	0.0%
	Total time lag (cross-multiplication)	44.7%	30.1%	18.6%	6.6%	0.0%	0.0%	0.0%
	Control and robustness test (public market proxy \Rightarrow private equity performance measurement)	73.1%	0.0%	26.9%	0.0%	0.0%	0.0%	0.0%
<i>Neoclassic theory: capital demand proxies</i>								
Capital expenditures	<i>to private equity activity measurement</i>	0.0%	0.0%	8.2%	27.9%	34.6%	29.3%	0.0%
	<i>to private equity performance measurement</i>	17.4%	7.7%	55.4%	19.6%	0.0%	0.0%	0.0%
	Total time lag (cross-multiplication)	18.7%	26.9%	23.2%	24.9%	6.2%	0.0%	0.0%
	Control and robustness test (public market proxy \Rightarrow private equity performance measurement)	10.0%	16.6%	20.1%	4.8%	14.9%	16.1%	17.6%
<i>Information asymmetry proxies</i>								
Price-to-book ratio (non-dividend only)	<i>to private equity activity measurement</i>	0.0%	0.0%	30.9%	37.4%	31.6%	0.0%	0.0%
	<i>to private equity performance measurement</i>	17.4%	7.7%	55.4%	19.6%	0.0%	0.0%	0.0%
	Total time lag (cross-multiplication)	44.6%	30.6%	18.3%	6.5%	0.0%	0.0%	0.0%
	Control and robustness test (public market proxy \Rightarrow private equity performance measurement)	60.4%	19.9%	19.8%	0.0%	0.0%	0.0%	0.0%
Δ Price-to-book ratio (dividend vs. non-dividend)	<i>to private equity activity measurement</i>	0.0%	0.0%	26.0%	34.6%	29.8%	9.6%	0.0%
	<i>to private equity performance measurement</i>	17.4%	7.7%	55.4%	19.6%	0.0%	0.0%	0.0%
	Total time lag (cross-multiplication)	38.5%	29.7%	18.1%	11.7%	2.0%	0.0%	0.0%
	Control and robustness test (public market proxy \Rightarrow private equity performance measurement)	23.2%	35.5%	21.5%	19.8%	0.0%	0.0%	0.0%
Time lag (cross-multiplication)		38.2%	29.6%	19.3%	11.2%	1.6%	0.0%	0.0%
Time lag (control and robustness test)		53.3%	14.4%	17.6%	4.9%	3.0%	3.2%	3.5%
Average time lag (based on the isolated testing results)³⁷		45.7%	22.0%	18.5%	8.1%	2.3%	1.6%	1.8%

Figures highlighted in **bold** indicate the time shift with the strongest correlation. Time Lag (cross-multiplication) and the respective sub-headers in the table depict the results of combinatorics matrix calculations determining possible arrangements of the accumulative time lags (i.e. proxy to activity and activity to performance).

Table 6: Results of summarizing testing of all hypotheses (incl. control and robustness test)

³⁷ The „Average time lag“ is the equally-weighted average of the time lags according to the cross-multiplication and according to the control and robustness test.

As mentioned earlier, Table 6 shows the time lag in percentage terms for both the cross-multiplication (of the results from hypotheses H-1 and H-2) as well as from the control and robustness test (see Table 5). The percentage figures are to be multiplied by the respective time lag they concern. Following this, the cross-multiplication method results in a time lag of 2.91 (vintage) years, whereas the control and robustness test suggests a slightly lower time lag of 2.86 (vintage) years. On average, these two isolated estimation approaches find that private equity performance increases (as depicted in Figure 15) with a time lag of 2.89 (vintage) years after upsurging public market proxies. These very close results show that the isolated testing approaches clearly validate each other. Further, due to the long-term investment period of private equity investments and the fact that private equity performance was assessed based on vintage years the time differences can be neglected.

Therefore, the following conclusion (as depicted in Figure 16) was derived based on the testing of the hypothesis H-3 as elaborated above in conjunction with the results depicted in Table 5 and 6:

H-3: The separate time lags identified as a result of the hypothesis testing H-1 and H-2 were verified by the control and robustness test through directly assessing the time lag between public market conditions and private equity performance.

Time lag between the public and private equity markets

illustrative summary of results

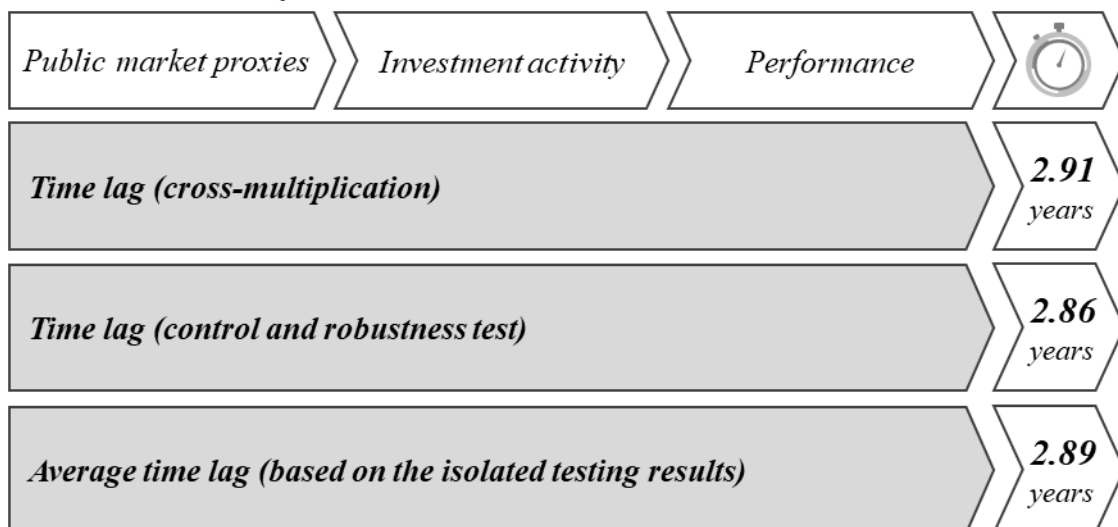


Figure 16: Time lag between the public and private equity markets

5 Conclusion

The public market was identified to positively correlate with investment activity. This suggests that favorable public market conditions lead to higher levels of fundraising and capital commitments in the private equity market. Further, the investment activity exhibits a positive correlation with private equity performance patterns. In both cases, the correlation is subject to a time lag. The increase of investment activity was identified to lag a bit less than one year behind the public market's upsurge. However, performance levels take longer to rise after increasing investment activity is observable. Current literature suggests that funds, which are raised during boom cycles, experience lower returns on an aggregated-level, among others, due to higher new entrants' ratios as inexperienced fund managers generally underperform well-established funds. Validity of the identified correlations for this two-phase approach was confirmed by the direct assessment of the correlation between the public market and private equity performance.

Based on public market proxies reflecting the neoclassical theory and the concept of information asymmetry, it was noted that three years after public market improved US private equity returns follows suit. This time lag does not refer to all US private equity fund in the market, but the ones which were raised three (vintage) years after improved public market conditions.

These results provide additional guidance of investors when deciding on the timing of potential US private equity investments. Nevertheless, one has to bear in mind that the results presented may apply to the examined data set, hence, only upcoming market developments can reaffirm their validity for the future.

6 Literature

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7 Appendices

As mentioned in sections 3.1 and 3.2, the empirical analysis is based on cash flow data provided by Preqin. All other data, which was used for this study, namely to construct the public market proxies, is disclosed in section 4.1.2 and is available via Bloomberg or other public sources (e.g. Fed).

For verifiability of this study's results, both the "raw dataset" provided by Preqin (Appendix A) as well as the "manipulated dataset" (Appendix B) are attached. Note that these attachments are of proprietary nature, hence, they are not attached or distributed as part of the publication of this thesis.

Overview of appendices:

- Appendix A – "Raw dataset" provided by Preqin
- Appendix B – "Manipulated dataset" compiled by the author